THE UNIVERSITY OF ALBERTA

# THE RELIABILITY OF GYMNASTIC RATINGS AND GYMNASTIC JUDGES

by

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A THESIS

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ABSTRACT

The purpose of this study was to estimate the reliability of gymnastic ratings and the reliability of gymnastic raters. It was also part of this study to compare four methods of assessing the performance score of the athletes.

In order to estimate the reliability of the ratings the analysis of variance was used. The coefficients of reliability of the ratings were closely related with the range of ability of the athletes. Higher coefficients were obtained for a heterogeneous group of athletes whereas lower coefficients were observed for a more homogeneous group.

The reliability of each judge was determined by the principal components method of factoring. A uni-factor model was proposed and it was suggested that the largest eigenvalue extracted from the factorial analysis of the ratings of each event be used to estimate the quality of the ratings and the raters.

Finally, the comparison by rank correlation, of four methods of assessing the performance score did not suggest to any large extent the superiority of one method over another.

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# CHAPTER 1

# THE PROBLEM

## Introduction

In many areas of human performance such as gymnastics, diving, skating and skiing, it is necessary to rely on the judgement of raters to assess the quality of a performance. There has probably never been a gymnastic competition where the athletes, the coaches, the organizers or even the spectators have not expressed bitter feelings about the more or less subjective ratings of the judges. As was pointed out by Festa (1963): Are the judges capable? or are not the people who criticize the judges prejudiced in favour of their own work?

The problem of having competent and objective judges at all levels of gymnastic competition has been difficult to solve. To this effect, Roetzhein and Muzyczko (1968) have indicated the necessity of instituting an objective and meaningful national ranking system for judges. At the present time, the test suggested by the FIG (Fédération Internationale de Gymnastique) does not seem sufficient to identify competence and objectivity in judging. Landers (1970) stated:

> It is therefore surprising that a sport which relies so heavily on human observers to determine the outcome of competition does not have more research knowledge concerning factors which may influence the accuracy of judges' scores.

FIG Code of Points

In order to improve on the objectivity of the judges in gymnastic competition, a set of rules was established in 1949. According to these rules (1968), four judges are used to determine the score of each performer. These four judges are supervised by a superior judge who also gives his rating of the performance. The net score of each gymnast is determined by taking the average of the middle two scores of the four judges mentioned above. This procedure is further governed by the following articles.

Article 11.1. All exercises are scored with points ranging from 0 to 10 with deductions of whole points, half points and tenths of points.

Article 11.2. The points difference between the two middle scores may not be greater than:

0.10 with an average of 9.60 or higher

0.20 with an average of 9.00 to 9.55

0.30 with an average of 8.00 to 8.95

0.50 with an average of 6.50 to 7.95

0.80 with an average of 4.00 to 6.45

1.00 in all other cases

When the difference between the two middle scores does not fall within the above range, the superior judge is consulted.

Article 9.0. His mark (superior judge) added to the average of the two middle marks of the four judges, divided by two, is the valid basic score. It is used for possible intervention in consultations when needed.

Article 17.0. The evaluation of optional exercises takes place on the basis of three evaluation factors:

(a) Difficulty

(b) Combination (formation of the exercise)

(c) Execution

The points are distributed in the following manner:

| | | | |
|---|---|---|---|
| (a) | Difficulty | 3.40 points | |
| (b) | Combination | 2.60 points | |
| | (a + b) | 6.00 points | (the actual value of an exercise) |
| (c) | Execution | 4.00 points | (for correct form and technically correct execution) |
| | (a + b + c) | 10.00 points | |

For the evaluation of the final competition, the jury in each event, as described by the FIG procedure, must be composed of:

Article 47.0. (b) Two superior judges and four judges of which one head judge and four judges must come from nations not participating in this event (neutral judges).

(c) If there should be a discussion and no common understanding be found between the two superior

judges the score to be given by the superior judges will be the average of their individual scores.

## Statement of the Problem

A gymnastic competition involves performance in six different events: floor exercises, horizontal bar, parallel bars, pommel horse, vault and rings. The foremost purpose of this study was to assess the reliability of gymnastic judges and the reliability of gymnastic ratings as obtained at four levels of gymnastic competition.

In addition, four methods to assess the performance score were compared:

1. The FIG method where the performance score is the average of the middle two ratings given by the four judges.

2. The unweighted composite method where the performance score is the average of the ratings of all the judges including the superior judge's rating.

3. The two most reliable judges' method where the performance score is derived from averaging the ratings of the two most reliable judges as obtained by the principal components method of factoring.

4. The weighted composite method where the performance score is a weighted and rescaled score derived by the principal components method of factoring.

## Samples

For this study, the ratings of four gymnastic competitions were analysed:

1. The National Gymnastic Meet held in Toronto in 1973. For this meet there were three levels of competition: optionals, compulsories and finals. The results for the junior men and senior men were analysed.

2. A dual meet between Canada and China held in Montreal in 1973.

3. The national trials held in Winnipeg in 1973.

4. A western intercollegiate meet held in Edmonton in 1971.

All together the ratings from fifty-four events were used for the study. The selection of the four meets was based solely on the availability of the results, and for this reason only the men's competitions were analysed.

## Significance of the Study

As previously indicated, very little research has been conducted to determine and evaluate the quality of the judging associated with gymnastic competitions.

Results from this study and subsequent similar studies, if done, could help the Canadian Gymnastic Federation in the selection of methods to establish standards related to the quality and objectivity of gymnastic ratings. It is understandable that the level of agreement between judges in

assessing gymnastic performance is higher in competitions where the athletes fall within a wide range of abilities and lower in situations where the range of abilities is narrower. Since the reliability of the ratings gives an estimate of this level of agreement between judges, the results from this study could be used as a starting point for the creation of standards of agreement between judges associated with gymnastic ratings.

Secondly, the assessment of individual judge reliability would certainly assist in making a better selection of judges based on an objective evaluation of their previous ratings.

Finally, a new ranking system of athletes obtained from a weighted composite score may be worthy of consideration.

# CHAPTER II

## REVIEW OF LITERATURE

As was noted in the introductory chapter, the FIG adopted a new system of rules in 1949 where the judging panel was composed of one superior judge and four other judges. The performance score was determined by taking the average of the middle two scores of the four judges. The superior judge would have the power to use his score if the difference between the two middle scores did not fall within the range set by the FIG (1968, Article 11.2).

## RESEARCH IN GYMNASTIC JUDGING

So far, little research has been done to evaluate the objectivity and the reliability of the judges selected to assess performance in gymnastic competition. However, four different commonly used approaches are revealed in the literature.

### Gross Scores Versus Net Scores

In this first approach, the purpose was to compare the standing of each competitor by taking the average of all the scores given by the judging panel (gross scores) to the conventional method of averaging the middle scores (net scores).

Results from the 1950 National Collegiate Athletic Association Gymnastic Meet were analysed by Hunsicker and Loken (1951). The gross scores were compared to the net scores and it was observed that differences in rank resulted.

Similar results were also observed at the National Collegiate Athletic Association Gymnastic Meet held at the University of Illinois, in April 1961. In this study, Faulkner and Loken (1962) used the average of the four judges (excluding the score of the superior judge) and compared these results with the average of the middle two scores.

So far this method does not give any evidence of the superiority, in terms of objectivity and reliability, of one method (gross scores) over the other (net scores) to assess the performance score.

## Range of Scores Versus Quality of Judging

A second approach was proposed by Calkin (1968, 1969) based on the assumption that the greater the range between scores given by all judges over the same performance the poorer the quality of judging would be. In order to take a "more objective look at a judge's performance", Calkin's first study analysed: (1) the number of times each judge's score was discarded because it was too high; (2) the number of times a judge's score was discarded because it was too low; (3) the number of times a judge's score was more

than the FIG range above the meet score; (4) the number of times a judge's score was more than the FIG range below the meet score; (5) the mean of all the scores given by each judge for each event.

In a follow-up study, the same author (1969) proposed to evaluate the work of individual officials and compared their ratings over a season. From these analyses it was concluded that events that were rated having a small rather than large difference between judges' scores were "objectively" better judged.

This method has helped in evaluating the performance of a judge but so far it has not been useful in the selection of judges in terms of their objectivity and reliability.

## Intercorrelations

A third approach, and one that has been used more frequently, was the utilization of the product moment correlation to determine the degree of agreement between the ratings of a judging panel.

Using inter-judge correlations, very low coefficients have been observed by Faulkner and Loken (1962) in the parallel bars, tumbling and free exercises events (0.41, 0.46, -0.11, 0.34, 0.27).

However, in another study when the intercorrelations among the five judges for the six events were determined by Hunsicker and Loken (1951), only one fell below 0.80. This would indicate a high level of agreement between the judges.

The purpose of Calkin's studies (1968, 1969) was to analyse the ratings of gymnastic judges. The inter-correlations among judges were given but there was no indication that the data used were real or not.

Bauer Method Versus FIG Method

A fourth method has been suggested whereby gymnastic routines would be evaluated on film. It was felt that this method would control external factors such as the effect of an audience, the presence of other athletes, the judges changing scores after a meet, the presence of other judges, etc. It would thus be possible to use more adequate statistical techniques to determine the reliability of each judge.

This last approach was used by Landers (1969). Two judging systems were compared: (1) the FIG system where each judge assigned numerical ratings for the following categories: difficulty, composition and execution. The performance score is the sum of the ratings on the three categories. (2) the Bauer system where the judges rate only one of the three categories. The performance score is determined by summing one judge's rating of difficulty, one judge's rating of composition and the average of two judge's ratings of execution.

Twelve qualitifed Bauer Variation judges who were used at the 1965 Big Ten gymnastic championship were selected as subjects to evaluate performance under the Bauer system.

For the FIG system twelve judges representing the Northern California Gymnastic Officials Association were selected.

All subjects viewed an 8 mm. film containing twenty-three routines. The first routine was also inserted at the end of the film and was used to determine each judge's reliability.

In order to compare both systems, an absolute rating of each routine was determined by the investigator and by a recognized authority in each of the respective observation system.

The results indicated a higher reliability for the judges under the Bauer system (0.853) as compared with the FIG judges (0.619). The author pointed out that these results clearly demonstrated the greater effectiveness of judges rating one rather than several observational categories.

But, since these results have never been duplicated and since great doubt should be expressed concerning the internal and external validity of the experiment in terms of the selection of the judges, non identical tasks for the two groups of judges and difficulty in generalizing to one system or the other, it would be hazardous to accept without question the conclusions of this study.

## ESTIMATES OF RELIABILITY

When dealing with psychological variables such as gymnastic ratings one is concerned with how reliable a judge

is in his ratings. Would an athlete, under the same conditions, obtain from a judge a similar score for an identical performance on different occasions?

Since it is well known that ratings by any judge may contain a certain component of error, one common practice has been to have several judges rate the same performance and average the ratings in order to determine the "true performance score" of the athlete. With some modifications this method has been used in situations such as skating, diving, skiing and gymnastics.

Reliability problems are thus related to the accuracy of the judges. In the area of mental tests several methods based on the Classical Test Theory Model (Lord and Novick, 1968, Magnusson, 1966 and Gulliksen, 1950) have been developed to assess the reliability of a measurement.

<u>Background: The Classical Model</u>

The basic equation of the Classical Model (Gulliksen, 1950) defines the observed score as being made up of a true component and an error component.

$$X = T + E \qquad (1)$$

By defining error as the difference between the observed score and the true score, this model considers only the random errors, called errors of measurement, and assumes that:

1. The expected value of these errors over a large number of parallel measurements is zero, that is:

$$E(E) = 0 \tag{2}$$

2. The correlation between true scores and error scores is zero.

$$r_{TE} = 0 \tag{3}$$

3. The correlation between the error scores on one test and the error scores on any other test is zero.

$$r_{E_g E_h} = 0 \tag{4}$$

4. The correlation between the true scores on one test and the error scores on another test is zero.

$$r_{T_g E_h} = 0 \tag{5}$$

Using the assumption that $E(E) = 0$, the expected true score is equal to the expected value of the observed scores,

$$E(T) = E(X) \tag{6}$$

and the variance of the observed scores is the sum of the true score variance and the error score variance, that is:

$$\sigma_x^2 = \sigma_t^2 + \sigma_e^2 \tag{7}$$

<u>Definition of parallel tests</u>. Two tests are said to be parallel when the expected values of the observed scores are the same in both tests, the variances are the same and

the errors of measurement are the same. These can be written as:

$$E(X_g) = E(X_h) \tag{8}$$

$$\sigma^2_{x_g} = \sigma^2_{x_h} \tag{9}$$

$$\sigma_{e_g} = \sigma_{e_h} \tag{10}$$

It is also part of parallel measurements that all intercorrelations between the tests are equal (Lord and Novick, p. 48, 1968).

<u>Reliability of parallel tests</u>. Reliability can be defined as the correlation between parallel tests. Starting with the equation of the correlation coefficient where

$$r_{x_g x_h} = \frac{\Sigma x_g x_h}{N \sigma_{x_g} \sigma_{x_h}} \tag{11}$$

and since

$$x_g = t_g + e_g \tag{12}$$

and

$$x_h = t_h + e_h \tag{13}$$

then

$$r_{x_g x_h} = \frac{\Sigma(t_g + e_g)(t_h + e_h)}{N \sigma_{x_g} \sigma_{x_h}} \tag{14}$$

Since $\sigma^2_{x_g} = \sigma^2_{x_h}$ from the definition of parallel tests and applying the assumptions of the Classical Model previously

defined, then the correlation between parallel tests is

$$r_{xx} = \frac{\sigma_t^2}{\sigma_x^2} \tag{15}$$

So the reliability of parallel tests is the ratio of true score variance to observed score variance. Similarly the correlation of true and observed scores is expressed as

$$r_{xt} = \frac{\Sigma_{xt}}{N\,\sigma_x\,\sigma_t} \tag{16}$$

Since $r_{te} = 0$, then

$$r_{xt} = \frac{\sigma_t^2}{\sigma_x\,\sigma_t} \tag{17}$$

By dividing both the numerator and denominator by $\sigma_t$, we write

$$r_{xt} = \frac{\sigma_t}{\sigma_x} \tag{18}$$

So

$$r_{xx} = r_{xt}^2 \tag{19}$$

or

$$r_{xt} = \sqrt{r_{xx}} \tag{20}$$

The correlation of true and observed scores as expressed by this last equation has been known as the index of reliability (Gulliksen, p. 23, 1950).

<u>The Spearman-Brown formula</u>. Previously we have defined reliability as the correlation between parallel tests, that is:

$$r_{xx} = \frac{\sigma_t^2}{\sigma_x^2} \tag{21}$$

When a test is increased in length by adding K parallel tests, the variance of the composite test composed of the sum of all the tests from 1 to K, is given by

$$\sigma_{tot}^2 = \sum_{g=1}^{K} \sigma_{x_g}^2 + \sum_{g=1}^{K} \sum_{\substack{h=1 \\ g \neq h}}^{K} r_{x_g x_h} \sigma_{x_g} \sigma_{x_h} \tag{22}$$

Since the variances of each test are equal and since we have K (K-1) covariance terms, we can write

$$\sigma_{tot}^2 = K \sigma_x^2 + K(K-1) r_{x_g x_h} \sigma_x^2 \tag{23}$$

which reduces to

$$\sigma_{tot}^2 = K \sigma_x^2 \left[ 1 + (K-1) r_{x_g x_h} \right] \tag{24}$$

Similarly, the true variance for the composite test is given by

$$\sigma_t^2 = \sum_{g=1}^{K} \sigma_{t_g}^2 + \sum_{g=1}^{K} \sum_{\substack{h=1 \\ g \neq h}}^{K} r_{t_g t_h} \sigma_{t_g} \sigma_{t_h} \tag{25}$$

From the assumptions of equal true variances and a correlation of 1.00 between the true scores, we obtain

$$\sigma_t^2 = K \sigma_{t_g}^2 + K(K-1) \sigma_{t_g}^2 \tag{26}$$

which reduces to

$$\sigma_t^2 = K^2 \sigma_{t_g}^2 \tag{27}$$

Thus the reliability of a test increased in length K times is expressed by

$$r_K = \frac{K^2 \sigma_t^2}{K \sigma_x^2 \left[1 + (K-1) r_{x_g x_h}\right]} \tag{28}$$

and since

$$r_{xx} = r_{x_g x_h} = \frac{\sigma_t^2}{\sigma_x^2} \tag{29}$$

then

$$r_K = \frac{K r_{xx}}{1 + (K-1) r_{xx}} \tag{30}$$

which is the well known Spearman-Brown formula for a test increased in length by K parallel tests.

<u>Reliability estimated by split halves methods</u>. A very common procedure to estimate the reliability of a test made up of many items has been to divide the test into two comparable halves and compute the correlation between the two halves. The coefficient obtained in this manner can be regarded as the reliability coefficient for one of the test halves. In order to obtain the reliability of the whole test, the Spearman-Brown formula is used to correct for halving the test length.

A similar procedure was established by Rulon (1939). The test was divided into two halves but the assumption of

equal observed variance was not necessary. His reliability coefficient was expressed by

$$r_{xx} = 1 - \frac{\sigma_d^2}{\sigma_{tot}^2} \tag{31}$$

It was shown that the variance of the differences in the observed scores between the two halves was equal to the error variance, and the reliability was given by

$$r_{xx} = 1 - \frac{\sigma_e^2}{\sigma_{tot}^2} \tag{32}$$

which is equivalent to equation 15.

A simpler equation which achieved the same result as Rulon's method was derived by Guttman (1945) and was expressed as

$$r_{xx} = 2\left[1 - \frac{(\sigma_{x_g}^2 + \sigma_{x_h}^2)}{\sigma_{tot}^2}\right] \tag{33}$$

When all items of a test are considered to be parallel to each other, there are many ways to divide the whole test into two halves. It was this problem of getting an average reliability coefficient for the whole test that led Kuder and Richardson (1937) to derive the following.

The total variance of a test composed of K items is given by

$$\sigma_{tot}^2 = \Sigma\sigma_i^2 + \frac{K\ (K-1)}{2}\ 2\ \Sigma\Sigma\ r_{ij}\ \sigma_i\ \sigma_j \tag{34}$$

Since $\sigma_i^2 = \sigma_j^2$ we can write

$$\frac{\sigma_{tot}^2 - \Sigma\sigma_i^2}{K\ (K-1)} = \overline{r_{ij}}\ \ \overline{\sigma_i}^{\,2} \tag{35}$$

where $\sigma_{tot}^2$ is the total test variance,

$\sigma_i^2$ is the variance for one item,

$K$ is the number of items,

$\overline{r_{ij}}$ is the average correlation between the K items,

$\overline{\sigma_i}^{\,2}$ is the average variance for the K items.

But

$$\overline{\sigma_i}^{\,2} = \Sigma \frac{\sigma_i^2}{K} \tag{36}$$

So

$$\overline{r_{ij}} = \frac{\sigma_{tot}^2 - \Sigma\sigma_i^2}{(K-1)\ \Sigma\sigma_i^2} \tag{37}$$

This last expression gives us the average correlation among the items. Because we have assumed equal intercorrelations among the items, $\overline{r_{ij}}$ also can be intepreted as the reliability coefficient of a single item. In order to obtain the reliability of the whole test, the Spearman-Brown formula is applied and we get

$$r_K = \frac{K\ \overline{r_{ij}}}{1 + (K-1)\ \overline{r_{ij}}} \tag{38}$$

Replacing the value of $\overline{r_{ij}}$ in equation 38 by equation 37, we write

$$r_k = K \left[ \frac{\sigma^2_{tot} - \Sigma\sigma^2_i}{(K-1)\ \Sigma\sigma^2_i} \right] \left[ \frac{1}{1 + (K-1)\ \dfrac{\sigma^2_{tot} - \Sigma\sigma^2_i}{(K-1)\ \Sigma\sigma^2_i}} \right] \tag{39}$$

which reduces to

$$r_k = \frac{K}{K-1} \left[ \frac{\sigma^2_{tot} - \Sigma\sigma^2_i}{\Sigma\sigma^2_i} \right] \left[ \frac{1}{\dfrac{\Sigma\sigma^2_i + \sigma^2_{tot} - \Sigma\sigma^2_i}{\Sigma\sigma^2_i}} \right] \tag{40}$$

and to

$$r_k = \frac{K}{K-1} \left[ \frac{\sigma^2_{tot} - \Sigma\sigma^2_i}{\Sigma\sigma^2_i} \right] \left[ \frac{1}{\dfrac{\sigma^2_{tot}}{\Sigma\sigma^2_i}} \right] \tag{41}$$

and finally to

$$r_k = \frac{K}{K-1} \left[ \frac{\sigma^2_{tot} - \Sigma\sigma^2_i}{\sigma^2_{tot}} \right] \tag{42}$$

Equation 42 is generally known as the K-R 20. The K-R 20 becomes a special case of Cronbach's coefficient alpha ($\alpha$) which is given by

$$\alpha = \frac{K}{K-1} \left[ 1 - \frac{\Sigma\sigma^2_i}{\sigma^2_{tot}} \right] \tag{43}$$

where $\sigma^2_i$ is the variance of each item after being weighted and $\sigma^2_{tot}$ is the total variance of the test made up of weighted items. The coefficient $\alpha$ is algebraically equal to "the average of all possible split half coefficients of a given test" (Cronbach, 1951, p. 300).

The Reliability of Ratings

The preceding discussion dealt with the reliability of tests made up of many items. Many split halves methods were presented and among them Rulon's common procedure from which the reliability of a test is given by

$$r_{xx} = 1 - \frac{\sigma_d^2}{\sigma_{tot}^2} \tag{75}$$

Form the model, Hoyt (1941) suggested that the variance of the differences ($\sigma_d^2$) was a measure of discrepancy between the observed variance and the true variance. Depending on how fortunate or unfortunate one is in dividing the test into two comparable halves, the reliability of the whole test could then be overestimated or underestimated. In order to seek a better estimate of this error variance Hoyt applied the analysis of variance to items scored either one or zero.

The "between subjects" and the "between items" sum of squares were subtracted from the total sum of squares in order to estimate the error variance which was given by

$$SS_E = SS_T - (SS_S + SS_I) \tag{45}$$

From the definition of reliability

$$r_{xx} = \frac{\sigma_{tot}^2 - \sigma_e^2}{\sigma_{tot}^2} \tag{46}$$

the estimation of the coefficient of reliability based on the analysis of variance was given by Hoyt as

$$r_{xx} = \frac{MS_T - MS_E}{MS_T} \qquad (47)$$

The author pointed out that the result obtained using the analysis of variance was equivalent to the result using the Kuder-Richardson formula 20.

Several authors have pointed out the use of the analysis of variance techniques in estimating the reliability of ratings (Horst, 1949; Ebel, 1951; Burt, 1955; Mahmoud, 1955; Engelhart, 1959; Maxwell and Pilliner, 1968; and Winer, 1971).

Essentially the development based on Winer's approach (1971, p. 273-296) is as follows:

the ratings received by a subject "i" from a judge "j" is expressed as

$$X_{ij} = \mu + \pi_i + \tau_j + e_{ij} \qquad (48)$$

where $\mu$ is the grand mean of the ratings.

$\pi_i$ is the true score component associated with subject "i".

$\tau_j$ is the difference between the mean rating of judge "j" and the grand mean "$\mu$".

$e_{ij}$ is the error of measurement associated with each subject and each judge.

This structural model assumes that the error component is normally distributed for each judge and the variance of errors is equal for all K judges that is

$$\sigma^2_{e_1} = \ldots\ldots = \sigma^2_{e_K} = \sigma^2_e \tag{49}$$

Similarly the true score component $\pi$ is also assumed to be normally distributed and does not vary from one judge to another over the same subject.

Assuming $\pi_i$ and $e_i$ uncorrelated, the variance of the ratings of judge "1" is given by

$$\sigma^2_{x_1} = \sigma^2_e + \sigma^2_\pi \tag{50}$$

Similarly the variance of the ratings of judge "2" is expressed by

$$\sigma^2_{x_2} = \sigma^2_e + \sigma^2_\pi \tag{51}$$

Under the assumptions that the errors are uncorrelated and that the correlation between error and true scores is zero, then the covariance becomes

$$\sigma_{x_1 x_2} = \sigma^2_\pi \tag{52}$$

To express the error variance we have

$$\sigma^2_{x_1} + \sigma^2_{x_2} = 2\ (\sigma^2_e + \sigma^2_\pi) \tag{53}$$

Dividing both side of the equation by 2 and replacing $\sigma^2_\pi$ by its equivalent $\sigma_{x_1 x_2}$, we get

$$\frac{\sigma_{x_1}^2 + \sigma_{x_2}^2}{2} - \sigma_{x_1 x_2} = \sigma_e^2 \tag{54}$$

which can also be defined as the difference between the mean variance and the mean covariance of the ratings that is:

$$\overline{VAR} - \overline{COV} = \sigma_e^2 \tag{55}$$

Using the reliability formula previously defined by

$$r_{xx} = \frac{\sigma_t^2}{\sigma_x^2} \tag{56}$$

and replacing $\sigma_t^2$ by $\sigma_{x_1 x_2}$, we get

$$r_{xx} = \frac{\sigma_{x_1 x_2}}{\sigma_x^2} \tag{57}$$

which is equivalent to

$$r_{xx} = \frac{\sigma_\pi^2}{\sigma_e^2 + \sigma_\pi^2} \tag{58}$$

From the analysis of variance model, the error variance ($\sigma_e^2$) can be directly estimated by the mean square residual ($MS_{RES}$). However, $\sigma_\pi^2$ cannot be directly estimated by the mean square for subjects ($MS_S$). Rather, it represents K times the variance of the means for each person, and each mean consists of a true component and an error component. Therefore, the true score variance can be estimated by

$$\frac{MS_S - MS_{RES}}{K} = \sigma_\pi^2 \tag{59}$$

Since the error variance is estimated by the mean square residual, the reliability of a single rating expressed by equation 58 becomes

$$r_1 = \frac{\dfrac{MS_S - MS_{RES}}{K}}{MS_{RES} + \dfrac{MS_S - MS_{RES}}{K}} \tag{60}$$

which reduces to

$$r_1 = \frac{K(MS_S - MS_{RES})}{K[MS_S - MS_{RES} + K(MS_{RES})]} \tag{61}$$

and to

$$r_1 = \frac{MS_S - MS_{RES}}{MS_S + (K-1)\, MS_{RES}} \tag{62}$$

This last equation represents the average reliability of the ratings which has been called by Ebel (1951) the intraclass coefficient of reliability.

Applying the Spearman-Brown transformation to equation 62 in order to obtain the reliability of the average ratings, we can write

$$r_K = K \left[ \frac{MS_S - MS_{RES}}{MS_S + (K-1)MS_{RES}} \right] \left[ \frac{1}{1+(K-1)\dfrac{MS_S - MS_{RES}}{MS_S + (K-1)MS_{RES}}} \right] \tag{63}$$

which reduces to

$$r_K = K\left[\frac{MS_S - MS_{RES}}{MS_S + (K-1)MS_{RES}}\right]\left[\frac{1}{\frac{MS_S + (K-1)MS_{RES} + (K-1)MS_S - (K-1)MS_{RES}}{MS_S + (K-1)MS_{RES}}}\right] \tag{64}$$

and to

$$r_K = K\left[\frac{MS_S - MS_{RES}}{MS_S + (K-1)MS_{RES}}\right]\left[\frac{MS_S + (K-1)\ MS_{RES}}{K(MS_S)}\right] \tag{65}$$

and finally to

$$r_K = \frac{MS_S - MS_{RES}}{MS_S} \tag{66}$$

As Ebel pointed out (1951, p. 412):

> The "between-raters" variance should be removed where the final ratings on which decisions are based consist of averages of complete sets of ratings from all observers or ratings which have been equated from rater to rater such as ranks, Z-scores, etc.

But if one wishes to include the judges' bias in situations where:

> decisions are made in practice by comparing single "raw scores" assigned to different pupils by different raters, or by comparing averages which come from different groups of raters, then the "between-raters" variance should be included as part of the error terms.

Following Winer's model, the "within-judges" mean square ($MS_W$) is used instead of the mean square residual to estimate the error variance. In this case the reliability coefficient of a single rating is given by:

$$r_1 = \frac{MS_S - MS_W}{MS_S + (K-1)\ MS_W} \tag{67}$$

and the reliability of the average ratings is expressed by:

$$r_K = \frac{MS_S - MS_W}{MS_S} \tag{68}$$

Reliability of Raters

The previous discussion dealt with the estimation of the reliability of the ratings. It was shown that the analysis of variance with repeated measures (Winer, 1971, p. 273-296) would provide such an estimation. Because ratings of the same performance vary from one judge to another, due to errors of measurement or consistent bias, it would be of interest to assess the reliability of each rater.

The factor analysis model and specially the uni-factor model as presented by Overall (1965) gives a solution to the estimation of rater reliability where it would be inappropriate to use the test-retest model.

One of the purposes of factor analysis is to explain the total common variance found between variables (Mulaik, 1972, p. 97). Generally this common variance is referred to as the communality of a variable and defined as the portion of the total variance that a variable has in common with the other variables in a given correlation matrix (Wrigley, 1957).

In the case of gymnastic ratings where non-zero correlations are observed, it follows that there exists some common variance among the judges. It is this common variance, based entirely upon true components, that accounts for the correlations between a judge and the others. Furthermore, perfect correlations would rarely be encountered and this lack of perfect correlation suggests the presence of unique variance that contributes to the total variance. Factor theory assumes that the unique variance is composed of two parts: variance that is reliable but specific to a test and error variance that arises from test unreliability, that is error of measurement (Wrigley, 1957).

In summary, the total variance of a test is made up of common variance or communality ($h^2$), specific variance ($s^2$) and error variance ($e^2$) which is referred to the unreliability of the test. The specific variance and the error variance forms the unique variance ($u^2$).

When the variables are expressed in standard-score form, that is with a mean of zero and a variance of one, then

$$\text{the total variance} = 1 = h^2 + s^2 + e^2 \qquad (69)$$

$$\text{the communality} = h^2 = 1 = u^2 \qquad (70)$$

$$\text{the unique variance} = u^2 = 1 - h^2 \qquad (71)$$

$$\text{the specific variance} = s^2 = u^2 - e^2 \qquad (72)$$

$$\text{the true variance} = h^2 + s^2 \tag{73}$$

$$\text{the error variance} = e^2 = 1 - r_{xx} \tag{74}$$

From the classical test theory model the reliability of a variable was previously defined as that part of the total variance that was true variance. It was given by:

$$r_{xx} = \frac{\sigma_t^2}{\sigma_x^2} \tag{75}$$

Replacing equations 73 and 69 respectively for the true variance and the total variance the reliability is defined as:

$$r_{xx} = \frac{h^2 + s^2}{h^2 + s^2 + e^2} \tag{76}$$

Since the total variance expressed in standard-score form is 1, equation 76 becomes

$$r_{xx} = h^2 + s^2 \tag{77}$$

Factor analysis does not provide for the estimation of the specific variance. However, it can be stated that the communality of a variable is at least a lower-bound estimate of the reliability of that variable as expressed by equation 77.

Common factor analysis. One of the purposes of factor analysis is to extract from the correlation matrix the minimum number of factors that will account for the common

variance among the variables and will reproduce as close as possible the original correlation matrix. To accomplish this task several methods have been developed such as: (1) the diagonal method of factoring (Mulaik, 1972), (2) the centroid method of factoring (Harman, 1967), (3) the principal components method (Hotelling, 1933), (4) Image analysis (Guttman, 1953) and (5) Alpha factor analysis (Kaiser and Caffrey, 1965).

One way of determining the common variance is to extract the factors one at a time. In this manner the correlations between each variable and that factor are found. The contribution of that factor to the common variance is then partialled out from the original correlation matrix. From this point we proceed to find the second factor on the remaining common variance. Each succeeding factor is obtained in the same manner.

The factor model. From the factor model a variable "J" can be expressed as:

$$Z_J = a_{J1}F_1 + a_{J2}F_2 + \ldots\ldots + a_{Jr}F_r + a_J U_J \qquad (78)$$

According to this model the common variance for variable "J" is accounted for by the factors $F_1$ to $F_r$ whereas the unique variance is determined by factor U. It is assumed (Mulaik, 1972, p. 103 and Harman, 1967, p. 17) that the common factors are uncorrelated with one another, that the common factors

are uncorrelated with the unique factors and furthermore the unique factors are uncorrelated with one another.

From the model, the common variance for variable J can be expressed by:

$$\sigma_J^2 = a_{J1}{}^2 + a_{J2}{}^2 + \ldots\ldots + a_{Jr}{}^2 \tag{79}$$

This is also an expression for the communality which is given as the sum of the squared loadings on the common factors.

<u>Factor solution</u>. When an investigator is interested in representing by a single score the performance assessed by a group of raters, as in gymnastic competition, the simplest way is to sum up all the ratings and form an unweighted composite score such as:

$$X_c = X_1 + X_2 + \ldots\ldots + X_K \tag{80}$$

The expected value of the composite score is given by:

$$E(X_c) = E(X_1 + X_2 + \ldots\ldots X_K) \tag{81}$$

and the variance by:

$$\sigma_c^2 = E[(X_c^2) - E(X_c)^2] \tag{82}$$

In the case where the expected value of the composite score is zero, the variance becomes:

$$\sigma_c^2 = E(X_c^2) \tag{83}$$

Because ratings vary from one judge to another in the assessment of a performance one could seek to understand the relative contribution of each rater to the composite score. A solution to this problem can be found by differentially weighting each component and partialling out their contribution to the total composite. The principal components method of factoring can be used in such a situation.

To form the composite score, a set of linear weights is applied to the components such as:

$$X_c = w_1X_1 + w_2X_2 + \ldots\ldots + w_K X_K \tag{84}$$

Similar to the unweighted case the variance of the weighted composite is given by:

$$\sigma_c^2 = E(X_c^2) \tag{85}$$

In terms of matrix equation, a weighted composite variable can be expressed by:

$$X_c = w'X \tag{86}$$

and the variance by

$$\sigma_c^2 = E(w'XX'w) \tag{87}$$

When the variables are expressed in standard-score form, equation 87 becomes:

$$\sigma_c^2 = E(w'ZZ'w) \tag{88}$$

But the correlations between the variables are given in matrix terms by:

$$R = E(ZZ') \tag{89}$$

So the variance of the weighted composite is stated as:

$$\sigma_c^2 = w'R\,w \tag{90}$$

The last equation gives the solution for the variance of a weighted composite when the components are differentially weighted. However, any constant value applied to the weights or any multiple of the weights also gives a solution for the variance of the composite. In order to obtain a variance of the composite that is a maximum but unique, it is necessary to introduce a restriction. The solution is found by setting the constraint that the sum of squares of the weights used is 1 or in matrix terms:

$$w'w = 1 \tag{91}$$

The task consists of finding the maximum of a function. To do so it is necessary to resort to derivative calculus. Furthermore, when a constraint is used the Lagrange multiplier $\lambda$ is introduced for the solution of the function. So

$$F = w'\,R\,w - \lambda(w'w - 1) \tag{92}$$

Using the derivatives for F and w, we get:

$$\frac{\partial F}{\partial w} = 2Rw - 2\lambda w \tag{93}$$

and setting the result equal to zero, we obtain:

$$Rw - \lambda w = 0 \tag{94}$$

and

$$(R - \lambda I)w = 0 \tag{95}$$

This last equation is known as the characteristic equation of the matrix R, and the roots $\lambda_1 \ldots\ldots \lambda_r$ are known as the characteristic roots, or latent roots or eigenvalues of the matrix R. From equation 94 we have

$$Rw = \lambda w \tag{96}$$

and we get

$$\lambda = w' R w \tag{97}$$

But previously the variance of the composite was given by:

$$\sigma_c^2 = w' R w \tag{98}$$

and would have to be equal to one of the latent roots $\lambda_1 \ldots\ldots \lambda_r$. Since the roots vary in magnitude, then the largest one would have to correspond to the maximum variance of the weighted composite when the constraint ($w'w = 1$) is introduced. Furthermore, the eigenvector associated with the largest eigenvalue corresponds to the set of weights to be applied to the variables to obtain the weighted composite.

By this method of factoring the sets of weights or eigenvectors have the property to be orthogonal to one another and the resulting components are mutually uncorrelated.

Previously the communality of a variable was defined as the sum of the squared loadings on the common factors for that variable. The loadings on the first factor are then given by the product of the square root of the largest eigenvalue and its associated eigenvector. The square root of the second largest eigenvalue multiplied by its associated vector forms the loadings on the second factor. The same procedure is used to find the loadings on the subsequent factors. Then the correlation matrix estimated by the first factor is given by:

$$R_1 = (w_1 \lambda_1^{1/2}) (w_1 \lambda_1^{1/2})' \quad (99)$$

since $R = w \lambda w'$ by equation 97.

Number of factors. It was previously stated that one purpose of factor analysis was to retain the minimum number of factors that would best reproduce the original correlation matrix. To that effect decision rules were developed and compared (Hakstian and Muller, 1973). Among those rules, Guttman (1954, 1956) suggested three approaches to estimate the communality of variables. From the definition of communality:

$$h^2 = 1 - u^2 \quad (100)$$

the problem is defined as follows: how many factors are necessary to account for the common variance among the variables.

The first lower-bound estimate of communality as defined by Guttman (1954, 1956), consists in factoring the correlation matrix with 1's in the main diagonal. The latent roots of the correlation matrix are computed and only those equal to or greater than 1 are retained. These also correspond to the number of factors to be retained.

Reliability estimated by factor analysis. A uni-factor model to estimate the reliability of raters was proposed by Overall (1965). The model is based on the assumption that ratings made by several raters should be perfectly correlated if it were not for independent errors of measurement. It should be stated that raters may have consistent biases, but the variance among raters would not be affected by those biases. When the correlation matrix is factored by the method of principal components only one latent root greater than one should be observed and thus only one factor would be necessary to account for the true variance (Laforge, 1965).

Recalling the definition of reliability based on the factor analysis components, that is:

$$r_{xx} = h^2 + s^2 \tag{101}$$

then the reliability of each judge would be determined by squaring the loadings on the first factor. This assumption would be true only if the uni-factor model holds, that is only one latent root greater than one is observed. In this case

loadings on subsequent factors would account for error variance or unreliability of the judges.

## SUMMARY

In the area of gymnastic judging four commonly used approaches to assess the quality of judging were revealed: (1) Gross scores versus net scores; (2), Range of scores versus quality of judging; (3) Intercorrelations; and (4) Bauer method versus FIG method.

It was felt by the author that more research was needed to estimate the reliability of the ratings and the reliability of the raters of gymnastic competitions. From the classical test theory model, the reliability of parallel tests was given by:

$$r_{xx} = \frac{\sigma_t^2}{\sigma_x^2}$$

and defined as the ratio of true score variance to observed score variance.

Several procedures to estimate the reliability of parallel tests by split halves methods were presented (Rulon, 1939; Guttman, 1945; Kuder-Richardson, 1937; Cronbach, 1951).

Many authors have pointed out the use of the analysis of variance techniques in estimating the reliability of ratings. Winer's approach (1971) was presented and the following four equations to estimate the reliability of

ratings were derived:

1. unadjusted estimate of the average reliability of the ratings:

$$r_1 = \frac{MS_s - MS_w}{MS_s + (K-1)MS_w}$$

2. unadjusted estimate of the reliability of the average ratings:

$$r_K = \frac{MS_s - MS_w}{MS_s}$$

3. adjusted estimate of the average reliability of the ratings:

$$r_1 = \frac{MS_s - MS_{RES}}{MS_s + (K-1)MS_{RES}}$$

4. adjusted estimate of the reliability of the average ratings:

$$r_K = \frac{MS_s - MS_{RES}}{MS_s}$$

Finally, the procedures for estimating the reliability of raters were given. A uni-factor model (Overall, 1965) derived from the principal components method of factoring was presented. From that model the reliability of a rater was defined as

$$r_{xx} = h^2 + s^2$$

and was obtained by squaring the loadings accounted for by each judge on the first factor. It was assumed that loadings on subsequent factors would account for error variance in the case where the uni-factor held.

# CHAPTER III

## RESULTS AND DISCUSSION

The gymnastic ratings obtained at four different levels of competition were analysed. The competitions were: (1) the Western Canadian Intercollegiate Athletic Association (WCIAA) meet held in Edmonton in 1971; (2) the Canadian National trials held in Winnipeg in 1973; (3) the Canada-China meet held in Montreal in 1973; and (4) the Canadian National meet held in Toronto in 1973. Altogether fifty-four events were analysed.

The first purpose of this study was to estimate the reliability of the gymnastic ratings. Based on the analysis of variance techniques (Ebel, 1951, Winer, 1971) the unadjusted coefficient of the average reliability of the ratings was obtained by using

$$r_1 = \frac{MS_S - MS_w}{MS_S + (K-1)MS_w} \tag{1}$$

When the "between-judges" variance was removed from the error term, an adjusted coefficient of the average reliability of the ratings was obtained. The following equation was used:

$$r_1 = \frac{MS_S - MS_{RES}}{MS_S + (K-1)MS_{RES}} \tag{2}$$

In order to estimate the reliability of the average ratings, the Spearman-Brown formula was used. For the unadjusted reliability of the average ratings the equation was:

$$r_k = \frac{MS_S - MS_W}{MS_S} \qquad (3)$$

and for the adjusted reliability it was given by:

$$r_k = \frac{MS_S - MS_{RES}}{MS_S} \qquad (4)$$

THE RELIABILITY OF THE RATINGS

The estimated coefficients of the reliability of the ratings as obtained by equations 1, 2, 3 and 4 are presented in Table 1. For the purpose of identifying each event the following abbreviations were used:

F - for the floor exercises event

H.B. - for the horizontal bar event

P.B. - for the parallel bars event

P.H. - for the pommel horse event

R - for the rings event

V - for the vault event

<u>Intercollegiate Meet: Edmonton, 1971</u>

The lowest unadjusted average reliability of the ratings was observed in the parallel bars event (0.811) and the highest in the floor exercises event (0.902). When,

TABLE 1

Reliability of the Ratings Obtained From the Analysis of Variance

| Events | N | Unadjusted $R_1$ | Unadjusted $R_k$ | Adjusted $R_1$ | Adjusted $R_k$ |
|---|---|---|---|---|---|
| | | Intercollegiate (WCIAA) Edmonton 1971 | | | |
| F | 26 | 0.902 | 0.979 | 0.905 | 0.979 |
| H.B. | 24 | 0.882 | 0.974 | 0.913 | 0.981 |
| P.B. | 27 | 0.811 | 0.945 | 0.818 | 0.947 |
| P.H. | 28 | 0.824 | 0.949 | 0.824 | 0.949 |
| R | 27 | 0.898 | 0.978 | 0.907 | 0.980 |
| V | 27 | 0.867 | 0.970 | 0.897 | 0.977 |
| | | National Trials: Winnipeg 1973 | | | |
| F | 6 | 0.814 | 0.956 | 0.812 | 0.956 |
| H.B. | 6 | 0.550 | 0.859 | 0.689 | 0.917 |
| P.B. | 6 | 0.670 | 0.910 | 0.668 | 0.909 |
| P.H. | 6 | 0.840 | 0.963 | 0.817 | 0.957 |
| R | 6 | 0.863 | 0.969 | 0.857 | 0.968 |
| V | 6 | 0.520 | 0.844 | 0.492 | 0.829 |
| | | Canada-China Meet: Montreal 1973 | | | |
| F | 12 | 0.727 | 0.930 | 0.755 | 0.939 |
| H.B. | 12 | 0.913 | 0.981 | 0.908 | 0.980 |
| P.B. | 12 | 0.896 | 0.977 | 0.895 | 0.977 |
| P.H. | 12 | 0.896 | 0.977 | 0.920 | 0.983 |
| R | 12 | 0.947 | 0.989 | 0.951 | 0.990 |
| V | 12 | 0.762 | 0.941 | 0.773 | 0.945 |

TABLE 1 (Continued)

| Event | N | Unadjusted $R_1$ | Unadjusted $R_k$ | Adjusted $R_1$ | Adjusted $R_k$ |
|---|---|---|---|---|---|
| National Meet: Senior Men's Finals Toronto 1973 | | | | | |
| F | 7 | 0.342 | 0.722 | 0.399 | 0.769 |
| H.B. | 4 | 0.851 | 0.966 | 0.882 | 0.974 |
| P.B. | 6 | 0.704 | 0.923 | 0.673 | 0.911 |
| P.H. | 7 | 0.856 | 0.967 | 0.862 | 0.969 |
| R | 7 | 0.626 | 0.893 | 0.647 | 0.902 |
| V | 7 | 0.789 | 0.949 | 0.799 | 0.952 |
| National Meet: Senior Men's Compulsories Toronto 1973 | | | | | |
| F | 17 | 0.888 | 0.975 | 0.889 | 0.976 |
| H.B. | 17 | 0.942 | 0.987 | 0.941 | 0.988 |
| P.B. | 17 | 0.920 | 0.983 | 0.927 | 0.985 |
| P.H. | 17 | 0.947 | 0.989 | 0.956 | 0.991 |
| R | 17 | 0.896 | 0.972 | 0.893 | 0.971 |
| V | 6 | 0.650 | 0.903 | 0.646 | 0.901 |
| National Meet: Senior Men's Optionals Toronto 1973 | | | | | |
| F | 17 | 0.890 | 0.970 | 0.889 | 0.970 |
| H.B. | 17 | 0.836 | 0.962 | 0.840 | 0.963 |
| P.B. | 17 | 0.902 | 0.974 | 0.901 | 0.973 |
| P.H. | 17 | 0.936 | 0.987 | 0.937 | 0.987 |
| R | 17 | 0.873 | 0.965 | 0.874 | 0.965 |
| V | 17 | 0.667 | 0.889 | 0.676 | 0.893 |

TABLE 1 (Continued)

| Event | N | Unadjusted $R_1$ | Unadjusted $R_k$ | Adjusted $R_1$ | Adjusted $R_k$ |
|---|---|---|---|---|---|
| National Meet: Junior Men's Finals Toronto 1973 | | | | | |
| F | 6 | 0.590 | 0.878 | 0.565 | 0.866 |
| H.B. | 6 | 0.706 | 0.923 | 0.779 | 0.946 |
| P.B. | 6 | 0.866 | 0.970 | 0.860 | 0.968 |
| P.H. | 6 | 0.814 | 0.956 | 0.799 | 0.952 |
| R | 6 | 0.577 | 0.872 | 0.551 | 0.860 |
| V | 6 | 0.706 | 0.923 | 0.695 | 0.919 |
| National Meet: Junior Men's Compulsories Toronto 1973 | | | | | |
| F | 22 | 0.761 | 0.941 | 0.800 | 0.952 |
| H.B. | 20 | 0.936 | 0.987 | 0.936 | 0.986 |
| P.B. | 23 | 0.772 | 0.944 | 0.775 | 0.945 |
| P.H. | 21 | 0.843 | 0.964 | 0.874 | 0.972 |
| R | 22 | 0.905 | 0.974 | 0.910 | 0.976 |
| V | 21 | 0.837 | 0.962 | 0.848 | 0.965 |
| National Meet: Junior Men's Optionals Toronto 1973 | | | | | |
| F | 22 | 0.888 | 0.969 | 0.887 | 0.969 |
| H.B. | 21 | 0.859 | 0.968 | 0.871 | 0.971 |
| P.B. | 25 | 0.882 | 0.968 | 0.881 | 0.967 |
| P.H. | 22 | 0.855 | 0.967 | 0.855 | 0.967 |
| R | 22 | 0.814 | 0.946 | 0.835 | 0.953 |
| V | 22 | 0.880 | 0.967 | 0.880 | 0.967 |

for all six events, the unadjusted reliability of the ratings was adjusted by removing from the error term the "between-judges" variance, all coefficients range between 0.818 and 0.913. In order to estimate the reliability of the average ratings the Spearman-Brown formula was used, and it was found that all estimated coefficients of reliability (adjusted and unadjusted) were above 0.945.

National Trials: Winnipeg, 1973

For the Canadian National trials, only six athletes were participating. The lowest coefficients for the average reliability of the ratings were observed in the horizontal bar event (0.550), the parallel bars event (0.670) and the vault event (0.520). For the other three events all coefficients were above 0.810. Similar results were observed when the coefficients for the average reliability of the ratings were adjusted. After the Spearman-Brown transformation, the coefficients of the reliability of the average ratings ranged between 0.829 and 0.969.

Canada-China Meet: Montreal, 1973

Six athletes from Canada and six athletes from China participated in the Canada-China gymnastic competition. The analysis showed that two coefficients for the average reliability of the ratings were below 0.80 (floor exercises, 0.727; vault, 0.762). Similar results were also observed for the adjusted coefficients. In relation to the reliability

of average ratings, all coefficients, unadjusted and adjusted were above 0.930.

National Meet: Senior Men

The six best athletes from the Compulsory and Optional competitions were selected to participate in the Finals. For that competition, a very low coefficient for the average reliability of the ratings was observed in the floor exercises event (0.342). For the other events the range for the same coefficient of reliability was between 0.626 and 0.856. The Spearman-Brown transformation yielded adjusted and unadjusted coefficients of reliability below 0.80 for the floor exercises event only.

From the ratings of the Compulsory competition, the average reliability of the ratings for the vault event was found to be 0.650 for the unadjusted coefficient and 0.646 for the adjusted coefficient. For all other events the reliability coefficients were above 0.888. The coefficients for the reliability of average ratings were above 0.90 for all six events.

Very similar results were observed in the ratings of the Optional competition. The lowest coefficients of reliability of the ratings were found in the vault event.

National Meet: Junior Men

In the Final competition, very low coefficients for the average unadjusted reliability of the ratings were

observed in the floor exercises event (0.590) and the rings event (0.577). For the vault and the horizontal bar events, the average reliability of the ratings was estimated at 0.706 and was above 0.800 for the other two events. The removal of the "between-judges" variance from the error variance yielded adjusted coefficients very similar to the unadjusted ones. The coefficients for the reliability of the average ratings, adjusted and unadjusted, were all above 0.860.

In the Compulsory competition the analysis of the average reliability of the ratings yielded coefficients that were all above 0.761. After the Spearman-Brown transformation all coefficients for the reliability of the average ratings were found to be above 0.941.

For the Optional competition all coefficients of the average reliability of the ratings and the reliability of the average ratings were above 0.810 for all events.

Discussion. The average reliability of the ratings gives an estimation of the level of agreement in the ratings as awarded by the different judges. However, the estimated reliability of the average ratings represents the extent to which the judges agreed collectively and also indicates the extent to which another panel of judges would have agreed in its ratings of the same performances (Akeju, 1972).

As was previously indicated, Ebel (1951), stated that the "between-judges" variance should be part of the

error term for assessing the average reliability of the ratings when decisions are made by comparing average scores which come from different groups of raters. In gymnastic competition this kind of decision is often made. For example, the six best athletes who performed at the National Meet in the Compulsory and Optional competitions were selected to participate in the Final competition according to their average scores for all the six events in the previous competitions. It would therefore be of great value if some standards relating to the quality of the ratings were available. This is not the case at the present time. So the author will attempt to establish arbitrarily, standards based upon the average reliability of the ratings.

It should be mentioned, as a general observation, that the higher the level of competition the lower the coefficient of the average reliability of the ratings. At the National Meet, these reliability coefficients were higher in the Compulsory and Optional competitions than they were in the Final competition in which the six best athletes from the previous two competitions competed. The same conclusion was observed where the coefficients of the average reliability of the ratings were higher for the Intercollegiate Meet than for the National Trials and the Finals (Senior and Junior Men) at the National Meet. However, this general principle does not apply to the coefficients of reliability obtained at the Canada-China Meet. Even though superior calibre athletes

participated, high coefficients of the average reliability of the ratings were observed.

It is therefore suggested that in order to quantify the quality of gymnastic ratings the following standards be used. When the level of competition is high, such as the National trials or the Finals of a National Meet, a coefficient of the average reliability is evaluated to be excellent if it is above 0.80. For competitions where a greater range is observed in the calibre of the athletes, such as at an intercollegiate meet, or the Compulsory and Optional competitions at a National Meet, the standard of excellence for the agreement of the ratings between different judges could be set at 0.90.

Evidently, other standards could also be established for lower levels of the extent of agreement between the ratings of the judges.

If these standards, mentioned above, were applied to the results presented in Table 1, the following events would receive the standard of excellent agreement between the judges in their ratings.

1. Intercollegiate Meet

| | |
|---|---|
| Floor exercises | 0.902 |

2. National Trials

| | |
|---|---|
| Floor exercises | 0.814 |
| Pommel horse | 0.840 |
| Rings | 0.863 |

3. Canada-China Meet

| | |
|---|---|
| Horizontal bar | 0.913 |
| Parallel bars | 0.896 |
| Pommel horse | 0.896 |
| Rings | 0.947 |

4. National Meet: Senior Men's Finals

| | |
|---|---|
| Horizontal bar | 0.851 |
| Pommel horse | 0.856 |

5. National Meet: Senior Men's Compulsories

| | |
|---|---|
| Horizontal bar | 0.942 |
| Parallel bars | 0.920 |
| Pommel horse | 0.947 |

6. National Meet: Senior Men's Optionals

| | |
|---|---|
| Parallel bars | 0.902 |
| Pommel horse | 0.936 |

7. National Meet: Junior Men's Finals

| | |
|---|---|
| Parallel bars | 0.866 |
| Pommel horse | 0.814 |

8. National Meet: Junior Men's Compulsories

| | |
|---|---|
| Horizontal bar | 0.936 |
| Rings | 0.905 |

9. National Meet: Junior Men's Optionals

none

In total, nineteen of the fifty-four events rated received the standard of excellent agreement when using the scale defined above.

# THE RELIABILITY OF THE JUDGES

As a second purpose, this study attempted to estimate the reliability of each judge. The reliability obtained by factor analysis was previously defined by:

$$r_{xx} = h^2 + s^2 \tag{5}$$

In order to estimate the reliability of each judge, a principal components factor analysis was computed for each of the fifty-four sets of ratings. A uni-factor model (Overall, 1965) was assumed and the reliability of each judge was obtained by squaring their loadings on the first factor. It was assumed that the loadings on subsequent factors would account for error variance.

For each event and for each competition, the reliability coefficients of the superior judge (S.J.) and the four other judges are presented in Table 2.*

## Intercollegiate Meet: Edmonton, 1971

From the results presented in Table 2, it was observed that the lowest reliability was obtained by Judge 2 in the pommel horse event (0.831). Out of twenty-eight coefficients of individual judge reliability, seventeen were above 0.90 and eleven were between 0.800 and 0.899.

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*It must be noted that the judging panel was not necessarily composed of the same persons from one event to another.

TABLE 2

Reliability of the Judges Estimated by

Principal Components Analysis

| Event | S.J. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| | Intercollegiate (WCIAA) Edmonton 1971 | | | | |
| F | 0.973 | 0.836 | 0.930 | 0.952 | 0.952 |
| H.B. | 0.963 | 0.951 | 0.952 | 0.895 | 0.927 |
| P.B. | 0.873 | 0.896 | 0.844 | 0.872 | |
| P.H. | 0.918 | 0.871 | 0.831 | 0.891 | |
| R | 0.964 | 0.872 | 0.912 | 0.943 | 0.939 |
| V | 0.916 | 0.944 | 0.883 | 0.921 | 0.945 |
| | National Trials: Winnipeg 1973 | | | | |
| F | 0.981 | 0.925 | 0.784 | 0.871 | 0.862 |
| H.B. | 0.947 | 0.561 | 0.842 | 0.807 | 0.761 |
| P.B. | 0.788 | 0.925 | 0.546 | 0.772 | 0.750 |
| P.H. | 0.924 | 0.903 | 0.958 | 0.929 | 0.738 |
| R | 0.951 | 0.958 | 0.895 | 0.986 | 0.653 |
| V | 0.910 | 0.688 | 0.261 | 0.961 | 0.985 |
| | Canada-China Meet: Montreal 1973 | | | | |
| F | 0.800 | 0.715 | 0.909 | 0.900 | 0.788 |
| H.B. | 0.917 | 0.954 | 0.979 | 0.965 | 0.915 |
| P.B. | 0.930 | 0.943 | 0.930 | 0.921 | 0.958 |
| P.H. | 0.976 | 0.941 | 0.948 | 0.942 | 0.980 |
| R | 0.976 | 0.985 | 0.958 | 0.984 | 0.920 |
| V | 0.684 | 0.839 | 0.826 | 0.928 | 0.808 |

TABLE 2 (Continued)

| Event | S.J. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| National Meet: Senior Men's Finals Toronto 1973 | | | | | |
| F | 0.734 | 0.542 | 0.303 | 0.688 | 0.810 |
| H.B. | 0.865 | 0.993 | 0.931 | 0.962 | 0.949 |
| P.B. | 0.803 | 0.892 | 0.792 | 0.515 | 0.824 |
| P.H. | 0.992 | 0.934 | 0.754 | 0.909 | 0.955 |
| R | 0.842 | 0.771 | 0.666 | 0.690 | 0.907 |
| V | 0.920 | 0.726 | 0.895 | 0.903 | 0.933 |
| National Meet: Senior Men's Compulsories Toronto 1973 | | | | | |
| F | 0.944 | 0.923 | 0.957 | 0.914 | 0.849 |
| H.B. | 0.956 | 0.948 | 0.956 | 0.964 | 0.965 |
| P.B. | 0.985 | 0.976 | 0.899 | 0.965 | 0.953 |
| P.H. | 0.984 | 0.970 | 0.965 | 0.990 | 0.981 |
| R | 0.939 | 0.919 | 0.895 | 0.935 | |
| V | 0.816 | 0.866 | 0.512 | 0.628 | 0.837 |
| National Meet: Senior Men's Optionals Toronto 1973 | | | | | |
| F | 0.948 | 0.955 | 0.838 | 0.934 | |
| H.B. | 0.914 | 0.933 | 0.772 | 0.967 | 0.913 |
| P.B. | 0.970 | 0.894 | 0.932 | 0.928 | |
| P.H. | 0.949 | 0.978 | 0.959 | 0.938 | 0.934 |
| R | 0.962 | 0.920 | 0.907 | 0.880 | |
| V | 0.801 | 0.769 | 0.845 | 0.736 | |

TABLE 2 (Continued)

| Event | S.J. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| National Meet: Junior Men's Finals Toronto 1973 | | | | | |
| F | 0.804 | 0.649 | 0.714 | 0.852 | 0.523 |
| H.B. | 0.959 | 0.933 | 0.752 | 0.734 | 0.895 |
| P.B. | 0.980 | 0.877 | 0.967 | 0.938 | 0.683 |
| P.H. | 0.937 | 0.921 | 0.599 | 0.939 | 0.857 |
| R | 0.959 | 0.743 | 0.314 | 0.879 | 0.646 |
| V | 0.886 | 0.433 | 0.913 | 0.977 | 0.806 |
| National Meet: Junior Men's Compulsories Toronto 1973 | | | | | |
| F | 0.926 | 0.815 | 0.865 | 0.787 | 0.880 |
| H.B. | 0.974 | 0.952 | 0.925 | 0.971 | 0.946 |
| P.B. | 0.897 | 0.960 | 0.788 | 0.832 | 0.741 |
| P.H. | 0.955 | 0.925 | 0.903 | 0.908 | 0.928 |
| R | 0.925 | 0.948 | 0.946 | 0.917 | |
| V | 0.925 | 0.893 | 0.920 | 0.943 | 0.723 |
| National Meet: Junior Men's Optionals Toronto 1973 | | | | | |
| F | 0.941 | 0.943 | 0.868 | 0.917 | |
| H.B. | 0.902 | 0.953 | 0.846 | 0.895 | 0.927 |
| P.B. | 0.917 | 0.949 | 0.912 | 0.900 | |
| P.H. | 0.892 | 0.947 | 0.922 | 0.859 | 0.825 |
| R | 0.936 | 0.929 | 0.867 | 0.849 | |
| V | 0.962 | 0.900 | 0.899 | 0.898 | |

National Trials: Winnipeg, 1973

For this competition the lowest coefficients of individual judge reliability were obtained by Judge 2 in the vault event (0.261), Judge 2 in the parallel bars event (0.546) and Judge 1 in the horizontal bar event (0.561). Out of thirty coefficients, fourteen were above 0.900, five were between 0.800 and 0.899, six were between 0.700 and 0.799 and five were below 0.700.

Canada-China Meet: Montreal, 1973

In this competition the lowest individual judge reliability was obtained by the superior judge in the vault event. Of the thirty coefficients estimated, twenty-three were above 0.900, four were between 0.800 and 0.899, two were between 0.700 and 0.799 and one was below 0.700.

National Meet: Senior Men's Finals

For this competition the lowest coefficients of individual judge reliability were obtained by Judge 2 in the floor exercises event (0.303), Judge 3 in the parallel bars event (0.515) and Judge 1 in the floor exercises event (0.542). From the thirty coefficients obtained, twelve were above 0.900, seven were between 0.800 and 0.899, five were between 0.700 and 0.799 and six were below 0.700.

National Meet: Senior Men's Compulsories

Out of twenty-nine coefficients of individual judge reliability for this competition, twenty-one were above

0.900, six were between 0.800 and 0.899 and two were below 0.700. The lowest coefficients were observed in the vault event for Judge 2 (0.512) and Judge 3 (0.628).

National Meet: Senior Men's Optionals

The lowest coefficient of individual judge reliability was obtained by Judge 3 in the vault event. Of the twenty-six coefficients obtained, eighteen were above 0.900, five were between 0.800 and 0.899 and three were between 0.700 and 0.799.

National Meet: Junior Men's Finals

In this competition, thirty coefficients of individual judge reliability were obtained. Eleven were above 0.900, eight were between 0.800 and 0.899, four were between 0.700 and 0.799 and seven were below 0.700. The lowest coefficient was observed for Judge 2 in the rings event (0.314).

National Meet: Junior Men's Compulsories

For this competition the lowest individual reliability coefficient was obtained by Judge 4 in the vault event. Out of the twenty-nine coefficients obtained, nineteen were above 0.900, six were between 0.800 and 0.899 and four were between 0.700 and 0.799.

National Meet: Junior Men's Optionals

Of the twenty-six coefficients of individual judge reliability, the lowest one was obtained by Judge 4 in the pommel horse event (0.825). Sixteen coefficients were above 0.900 and ten were between 0.800 and 0.899.

In summary, 258 coefficients of individual judge reliability were computed and 151 were above 0.900 (58.5%), 62 were between 0.900 and 0.899 (24.0%), 24 were between 0.700 and 0.799 (9.3%) and 21 were below 0.700 (8.1%).

The Uni-Factor Model

It was also part of the individual judge reliability problem to test for the uni-factor model (Overall, 1965). The first lower bound estimate of communality as defined by Guttman (1954, 1956) was used as the decision rule for the number of factors to retain which corresponds to the number of eigenvalues greater than one.

For each event and for each competition, the largest eigenvalue ($\lambda_1$), the second largest eigenvalue ($\lambda_2$), the proportion of the total variance accounted for by the largest eigenvalue ($\sigma^2_{\lambda 1}$) and the proportion of the total variance accounted for by the second largest eigenvalue ($\sigma^2_{\lambda 2}$) are presented in Table 3.

For all fifty-four principal components analyses performed, only one factor was retained since there was no more than one eigenvalue greater than one for each analysis.

For all the events and for each competition, the mean of the proportion of the total variance accounted for by the

TABLE 3

Eigenvalues and Proportion of Variance.

A Test of the Uni-Factor Model

| Events | $\lambda_1$ | $\lambda_2$ | $\%\sigma^2_{\lambda 1}$ | $\%\sigma^2_{\lambda 2}$ |
|---|---|---|---|---|
| | | Intercollegiate Meet: Edmonton 1971 | | |
| F | 4.644 | 0.204 | 92.879 | 4.086 |
| H.B. | 4.689 | 0.143 | 93.781 | 2.862 |
| P.B. | 3.485* | 0.244 | 87.119 | 6.104 |
| P.H. | 3.510* | 0.248 | 87.751 | 6.203 |
| R | 4.629 | 0.166 | 92.572 | 3.326 |
| V | 4.610 | 0.171 | 92.205 | 3.424 |
| | | National Trials: Winnipeg 1973 | | |
| F | 4.423 | 0.304 | 88.451 | 6.080 |
| H.B. | 3.918 | 0.668 | 78.362 | 13.369 |
| P.B. | 3.781 | 0.812 | 75.625 | 16.232 |
| P.H. | 4.452 | 0.455 | 89.037 | 9.102 |
| R | 4.442 | 0.481 | 88.841 | 9.626 |
| V | 3.805 | 0.988 | 76.095 | 19.765 |
| | | Canada-China Meet: Montreal 1973 | | |
| F | 4.112 | 0.434 | 82.233 | 8.676 |
| H.B. | 4.730 | 0.170 | 94.595 | 3.399 |
| P.B. | 4.683 | 0.124 | 93.665 | 2.486 |
| P.H. | 4.787 | 0.110 | 95.743 | 2.193 |
| R | 4.822 | 0.104 | 96.447 | 2.078 |
| V | 4.084 | 0.444 | 81.675 | 8.880 |

TABLE 3 (Continued)

| Events | $\lambda_1$ | $\lambda_2$ | $\%\sigma^2_{\lambda 1}$ | $\sigma^2_{\lambda 2}$ |
|---|---|---|---|---|
| | | Senior Men's Finals: Toronto 1973 | | |
| F | 3.078 | 0.879 | 61.568 | 17.577 |
| H.B. | 4.700 | 0.223 | 94.007 | 4.459 |
| P.B. | 3.827 | 0.725 | 76.534 | 14.503 |
| P.H. | 4.544 | 0.334 | 90.888 | 6.680 |
| R | 3.875 | 0.629 | 77.507 | 12.584 |
| V | 4.377 | 0.389 | 87.536 | 7.785 |
| | | Senior Men's Compulsories: Toronto 1973 | | |
| F | 4.586 | 0.225 | 91.729 | 4.499 |
| H.B. | 4.789 | 0.102 | 95.771 | 2.047 |
| P.B. | 4.778 | 0.136 | 95.564 | 2.729 |
| P.H. | 4.890 | 0.047 | 97.809 | 0.944 |
| R | 3.687* | 0.142 | 92.173 | 3.555 |
| V | 3.659 | 0.626 | 73.174 | 12.525 |
| | | Senior Men's Optionals: Toronto 1973 | | |
| F | 3.676* | 0.212 | 91.897 | 5.307 |
| H.B. | 4.500 | 0.288 | 89.998 | 5.765 |
| P.B. | 3.724* | 0.164 | 93.109 | 4.112 |
| P.H. | 4.758 | 0.107 | 95.160 | 2.131 |
| R | 3.669* | 0.189 | 91.732 | 4.722 |
| V | 3.151* | 0.401 | 78.771 | 10.015 |

TABLE 3 (Continued)

| Events | $\lambda_1$ | $\lambda_2$ | $\sigma^2_{\lambda 1}$ | $\sigma^2_{\lambda 2}$ |
|---|---|---|---|---|
| | | Junior Men's Finals: Toronto 1973 | | |
| F | 3.540 | 0.847 | 70.810 | 16.943 |
| H.B. | 4.273 | 0.377 | 85.455 | 7.533 |
| P.B. | 4.446 | 0.434 | 88.916 | 8.673 |
| P.H. | 4.253 | 0.552 | 85.051 | 11.044 |
| R | 3.541 | 0.961 | 70.817 | 19.219 |
| V | 4.015 | 0.663 | 80.293 | 13.269 |
| | | Junior Men's Compulsories: Toronto 1973 | | |
| F | 4.273 | 0.338 | 85.465 | 6.765 |
| H.B. | 4.768 | 0.101 | 95.363 | 2.010 |
| P.B. | 4.218 | 0.319 | 84.367 | 6.371 |
| P.H. | 4.620 | 0.149 | 92.407 | 2.976 |
| R | 3.735* | 0.111 | 93.368 | 2.785 |
| V | 4.404 | 0.348 | 88.083 | 6.967 |
| | | Junior Men's Optionals: Toronto 1973 | | |
| F | 3.670* | 0.221 | 91.741 | 5.516 |
| H.B. | 4.522 | 0.199 | 90.441 | 3.982 |
| P.B. | 3.678* | 0.158 | 91.949 | 3.951 |
| P.H. | 4.445 | 0.241 | 88.908 | 4.815 |
| R | 3.580* | 0.212 | 89.504 | 5.295 |
| V | 3.660* | 0.160 | 91.494 | 3.989 |

*Obtained from the ratings of four judges.

largest eigenvalue was as follows:

| | | |
|---|---|---|
| 1. | Intercollegiate Meet | 91.052% |
| 2. | National Trials | 82.735% |
| 3. | Canada-China Meet | 90.726% |
| 4. | National Meet: Senior Men's Finals | 81.340% |
| 5. | National Meet: Senior Men's Compulsories | 91.037% |
| 6. | National Meet: Senior Men's Optionals | 90.111% |
| 7. | National Meet: Junior Men's Finals | 80.223% |
| 8. | National Meet: Junior Men's Compulsories | 89.842% |
| 9. | National Meet: Junior Men's Optionals | 90.673% |

Discussion. From the individual judge reliability coefficients presented in Table 2, the average judge reliability coefficient was obtained for each event in each competition and these averages are presented in Table 4. Since each individual judge reliability coefficient was determined by squaring the loading of each judge on the first factor, the average judge reliability coefficients presented in Table 4 correspond to the proportion of the total variance accounted for by the largest eigenvalue in each event. These proportions are shown in Table 3.

It should be pointed out that the coefficients for the average judge reliability as obtained by factor analysis are slightly higher than the coefficients of the average reliability of the ratings ($R_1$ unadjusted) estimated by the analysis of variance. In the analysis of variance the

TABLE 4

Average Judge Reliability for Each Event

in Each Competition

| Event | Average Judge Reliability | Average Judge Reliability | Average Judge Reliability |
|---|---|---|---|
| | Edmonton | Winnipeg | Montreal |
| F | 0.928 | 0.884 | 0.822 |
| H.B. | 0.937 | 0.783 | 0.946 |
| P.B. | 0.871 | 0.756 | 0.936 |
| P.H. | 0.877 | 0.890 | 0.957 |
| R | 0.926 | 0.888 | 0.964 |
| V | 0.921 | 0.761 | 0.817 |
| | National Meet: Senior Men | | |
| | Finals | Compulsories | Optionals |
| F | 0.615 | 0.917 | 0.918 |
| H.B. | 0.940 | 0.957 | 0.899 |
| P.B. | 0.765 | 0.955 | 0.931 |
| P.H. | 0.908 | 0.978 | 0.951 |
| R | 0.775 | 0.922 | 0.917 |
| V | 0.875 | 0.731 | 0.787 |
| | National Meet: Junior Men | | |
| | Finals | Compulsories | Optionals |
| F | 0.708 | 0.854 | 0.917 |
| H.B. | 0.854 | 0.953 | 0.904 |
| P.B. | 0.889 | 0.843 | 0.919 |
| P.H. | 0.850 | 0.923 | 0.889 |
| R | 0.708 | 0.934 | 0.895 |
| V | 0.803 | 0.880 | 0.914 |

observed ratings of the judges are manipulated without any differential weighting (Burt, 1955) whereas differential weights are used in factor analysis. A comparison of the reliability coefficients obtained by these two techniques was studied by Mahmoud (1955) and the author suggested that the coefficient obtained by factor analysis "provides the most appropriate estimate of reliability". It was also suggested, in situations where non negative weights are found, that the true components would contribute to a greater proportion of the total variance. Consequently a greater estimate of the reliability coefficient would be observed.

As was done with the average reliability of the ratings, standards of excellence could be established for the individual judge reliability coefficients. Similarly we could arbitrarily select a coefficient of 0.90 and above to qualify an excellent rater in situations where a large range of ability exists among the athletes. Coefficients between 0.80 and 0.89 could be selected to define an excellent rater where the range of athletes' ability is much narrower. When these standards are applied to the results presented in Table 2, we find that 175 judges (67.8%) received the standard of excellent rater.

Furthermore, the quality of the judging of an event could be assessed by using the proportion of the total variance accounted for by the largest eigenvalue extracted from the factorial analysis. As before, 80% of the total

variance could be selected to represent excellent judging in situations where the athletes are more homogeneous in terms of their abilities, and select 90% to represent excellent judging of competitions where the athletes are more heterogeneous. When these standards were applied to the results presented in Table 3, it was found that eight events out of twenty-four were below the standard of 80% for the National Trials, the Canada-China Meet, and the finals for the Junior and Senior Men at the National Meet. In the other competitions analysed, ten events out of thirty were below the standard of 90% to represent excellent judging.

The same standards could also be applied to a competition as a whole. In this case, it is suggested that the mean of the proportion of variance accounted for by the six events in the same competition be used. (These averages were previously presented on page 61).

Applying these standards to the nine competitions analysed, only the compulsory competition for the Junior men at the National Meet fell below the standard of 90%. So, for eight of the nine competitions the standard of excellent judging can be applied to the ratings.

## PERFORMANCE SCORE ASSESSMENT METHODS

It was also a purpose of this study to compare four methods of assessing the performance score of each athlete.

The first method dealt with the weighted composite score. As previously stated, the characteristic equation of the correlation matrix R was given by:

$$(R - \lambda I)w = 0 \qquad (6)$$

Since the variance of the weighted composite was given by:

$$\sigma_c^2 = w' R w \qquad (7)$$

and that

$$\lambda = w' R w \qquad (8)$$

then the largest eigenvalue of the correlation matrix was equivalent to the variance of the weighted composite. Associated with the largest eigenvalue was a vector of weights (w) to be applied to the standard Z-scores to form the weighted composite. In order to maximize the variance of the weighted composite and obtain a unique solution, the constraint that the sum of the squares of the weights equals 1 was introduced, that is:

$$w'w = 1 \qquad (9)$$

The weighted composite in standard score form was obtained by:

$$C = Z w \lambda^{-1/2} \qquad (10)$$

where C is the weighted composite

Z is the matrix of Z-scores

w is the vector of weights associated with the largest eigenvalue

$\lambda$ is the largest eigenvalue.

It was then necessary for purposes of comparison with other score assessment methods, to rescale the weighted composite. This was done by multiplying the weighted composite by the mean variance of the judges as obtained from the ratings. The grand mean of the ratings was then added to the rescaled weighted composite.

The second method of performance score assessment consisted of taking the arithmetic mean of the ratings received by each subject in order to obtain an unweighted mean score.

The F.I.G. mean score was obtained by averaging the middle two scores of the four judges, excluding the superior judge's score. This became the third method of score assessment.

In the fourth method, the performance score was determined by averaging the ratings given by the two most reliable judges.

A Kendall rank correlation (Siegel, 1956, p. 213-222) was then calculated between the four score assessment methods. The results are presented in Table 5.

As a general observation, very high coefficients of correlation were obtained between the different score assessment methods. However, low coefficients of correlation were

TABLE 5

Rank Correlations Between Performance Score Assessment Methods

1 = Weighted Composite Score

2 = Unweighted Mean Score

3 = FIG Score

4 = Average Score of the Two Highest Reliable Judges

| | 1 vs 2 | 1 vs 3 | 1 vs 4 | 2 vs 3 | 2 vs 4 | 3 vs 4 |
|---|---|---|---|---|---|---|
| Intercollegiate Meet (WCIAA) Edmonton 1971 | | | | | | |
| F | 1.000 | 0.930 | 0.871 | 0.930 | 0.871 | 0.853 |
| H.B. | 0.998 | 0.973 | 0.925 | 0.974 | 0.927 | 0.937 |
| P.B. | 0.993 | 0.934 | 0.906 | 0.930 | 0.913 | 0.873 |
| P.H. | 0.989 | 0.943 | 0.932 | 0.932 | 0.922 | 0.925 |
| R | 0.999 | 0.940 | 0.881 | 0.941 | 0.883 | 0.878 |
| V | 0.989 | 0.903 | 0.878 | 0.903 | 0.890 | 0.900 |
| Mean | 0.995 | 0.937 | 0.899 | 0.935 | 0.901 | 0.894 |

TABLE 5 (Continued)

| | 1 vs 2 | 1 vs 3 | 1 vs 4 | 2 vs 3 | 2 vs 4 | 3 vs 4 |
|---|---|---|---|---|---|---|
| National Trials: Winnipeg 1973 | | | | | | |
| F | 1.000 | 0.894 | 0.828 | 0.894 | 0.828 | 0.772 |
| H.B. | 0.867 | 0.867 | 0.867 | 1.000 | 0.733 | 0.733 |
| P.B. | 0.867 | 0.867 | 1.000 | 1.000 | 0.867 | 0.867 |
| P.H. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| R | 1.000 | 1.000 | 0.867 | 1.000 | 0.867 | 0.867 |
| V | 0.966 | 0.867 | 0.966 | 0.897 | 1.000 | 0.828 |
| Mean | 0.950 | 0.916 | 0.921 | 0.965 | 0.883 | 0.845 |
| Canada-China Meet: Montreal 1973 | | | | | | |
| F | 0.939 | 0.938 | 0.862 | 0.938 | 0.862 | 0.921 |
| H.B. | 0.992 | 0.901 | 0.907 | 0.908 | 0.914 | 0.914 |
| P.B. | 0.992 | 0.853 | 0.915 | 0.859 | 0.822 | 0.937 |
| P.H. | 0.992 | 0.853 | 0.892 | 0.828 | 0.930 | 0.787 |
| R | 0.985 | 0.930 | 0.785 | 0.976 | 0.830 | 0.917 |
| V | 0.992 | 0.945 | 0.875 | 0.953 | 0.882 | 0.893 |
| Mean | 0.982 | 0.903 | 0.873 | 0.910 | 0.873 | 0.895 |

TABLE 5 (Continued)

| | 1 vs 2 | 1 vs 3 | 1 vs 4 | 2 vs 3 | 2 vs 4 | 3 vs 4 |
|---|---|---|---|---|---|---|
| | | | Toronto Senior Men's Finals | | | |
| F | 0.905 | 1.000 | 0.810 | 0.905 | 0.905 | 0.810 |
| H.B. | 1.000 | 0.333 | 0.667 | 0.333 | 0.667 | 0.667 |
| P.B. | 0.966 | 0.733 | 0.600 | 0.897 | 0.759 | 0.867 |
| P.H. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| R | 1.000 | 0.976 | 1.000 | 0.976 | 1.000 | 1.000 |
| V | 1.000 | 1.000 | 0.878 | 1.000 | 0.878 | 0.878 |
| Mean | 0.979 | 0.840 | 0.826 | 0.852 | 0.868 | 0.870 |
| | | | Senior Men's Compulsories: Toronto 1973 | | | |
| F | 1.000 | 0.967 | 0.959 | 0.967 | 0.959 | 0.948 |
| H.B. | 0.982 | 0.948 | 0.893 | 0.967 | 0.911 | 0.915 |
| P.B. | 1.000 | 0.948 | 0.941 | 0.948 | 0.941 | 0.948 |
| P.H. | 0.982 | 0.952 | 0.926 | 0.956 | 0.900 | 0.886 |
| R | 1.000 | 0.956 | 0.919 | 0.956 | 0.919 | 0.874 |
| V | 0.958 | 0.894 | 0.862 | 0.901 | 0.802 | 0.863 |
| Mean | 0.987 | 0.944 | 0.917 | 0.949 | 0.905 | 0.906 |

TABLE 5 (Continued)

| | 1 vs 2 | 1 vs 3 | 1 vs 4 | 2 vs 3 | 2 vs 4 | 3 vs 4 |
|---|---|---|---|---|---|---|
| | | | Senior Men's Optionals: Toronto 1973 | | | |
| F | 0.978 | 0.919 | 0.787 | 0.910 | 0.808 | 0.823 |
| H.B. | 0.967 | 0.897 | 0.859 | 0.945 | 0.877 | 0.933 |
| P.B. | 0.996 | 0.955 | 0.912 | 0.959 | 0.900 | 0.955 |
| P.H. | 0.996 | 0.948 | 0.937 | 0.967 | 0.926 | 0.944 |
| R | 1.000 | 0.978 | 0.929 | 0.978 | 0.929 | 0.966 |
| V | 0.971 | 0.915 | 0.877 | 0.915 | 0.847 | 0.811 |
| Mean | 0.985 | 0.935 | 0.884 | 0.946 | 0.881 | 0.905 |
| | | | Junior Men's Finals: Toronto 1973 | | | |
| F | 1.000 | 0.966 | 1.000 | 0.966 | 1.000 | 0.966 |
| H.B. | 0.867 | 1.000 | 0.867 | 0.867 | 0.733 | 0.867 |
| P.B. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| P.H. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| R | 0.867 | 0.828 | 0.867 | 0.966 | 0.733 | 0.759 |
| V | 0.867 | 0.828 | 1.000 | 0.690 | 0.867 | 0.759 |
| Mean | 0.934 | 0.937 | 0.956 | 0.915 | 0.889 | 0.892 |

TABLE 5 (Continued)

| | 1 vs 2 | 1 vs 3 | 1 vs 4 | 2 vs 3 | 2 vs 4 | 3 vs 4 |
|---|---|---|---|---|---|---|
| **Junior Men's Compulsories: Toronto 1973** | | | | | | |
| F | 0.989 | 0.920 | 0.943 | 0.939 | 0.946 | 0.885 |
| H.B. | 0.997 | 0.963 | 0.931 | 0.976 | 0.944 | 0.904 |
| P.B. | 0.984 | 0.953 | 0.912 | 0.953 | 0.904 | 0.865 |
| P.H. | 0.981 | 0.943 | 0.952 | 0.943 | 0.933 | 0.914 |
| R | 1.000 | 0.950 | 0.827 | 0.950 | 0.827 | 0.867 |
| V. | 0.990 | 0.933 | 0.916 | 0.923 | 0.906 | 0.877 |
| Mean | 0.990 | 0.944 | 0.914 | 0.947 | 0.910 | 0.885 |
| **Junior Men's Optionals: Toronto 1973** | | | | | | |
| F | 1.000 | 0.980 | 0.946 | 0.980 | 0.946 | 0.939 |
| H.B. | 0.981 | 0.911 | 0.878 | 0.930 | 0.897 | 0.898 |
| P.B. | 0.993 | 0.943 | 0.899 | 0.936 | 0.906 | 0.916 |
| P.H. | 0.989 | 0.915 | 0.878 | 0.900 | 0.862 | 0.927 |
| R | 0.974 | 0.948 | 0.953 | 0.948 | 0.861 | 0.886 |
| V | 0.983 | 0.914 | 0.839 | 0.914 | 0.857 | 0.861 |
| Mean | 0.987 | 0.935 | 0.899 | 0.935 | 0.888 | 0.906 |

obtained in some situations where a small number of athletes participated in the event. For example, the coefficients of correlation between the scoring methods for the horizontal bar event (National Meet, Senior Men's Finals) were 1.000, 0.333, 0.667, 0.333, 0.667, 0.667, but only four athletes participated in that event.

With a large number of subjects the rank correlation coefficients tend to be very high. For example, the lowest rank correlation coefficient at the National Meet, Junior Men's Optionals was 0.839, for the Junior Men's Compulsories, 0.827, the Senior Men's Optionals, 0.787, and for the Senior Men's Compulsories, 0.802. For the Intercollegiate Meet the lowest rank correlation was found to be 0.871.

For each combination of scoring methods the mean of the rank correlation coefficients for the six events within the same competition was obtained. For seven of the nine competitions analysed, it was found that the mean rank correlation between the weighted composite score and the unweighted mean score was higher than the mean rank correlation of any other combination of methods. An exception to this was the mean rank correlation between the unweighted mean score and the F.I.G. score at the National Trials, and between the weighted composite score and the average score of the two most reliable judges for the Junior Men's Finals at the National Meet.

In summary, small differences in the rank correlation coefficients were generally observed among the four methods of score assessment. Greater differences were found in situations where a small number of athletes participated in an event. These results, however, do not clearly indicate the superiority of one method over another.

CHAPTER IV

# SUMMARY AND CONCLUSIONS

## Summary

The foremost purpose of this study was to estimate the reliability of gymnastic ratings and the reliability of gymnastic raters. It was also a purpose of this study to compare different methods of assessing the performance score of each athlete.

The ratings of four competitions were analysed:

1. Intercollegiate Meet: Edmonton 1971
2. National Trials: Winnipeg 1973
3. Canada-China Meet: Montreal 1973
4. National Meet: Toronto 1973.

In order to estimate the reliability of the ratings, the analysis of variance was used and standards of excellence of the ratings were suggested in relation with the average reliability of the ratings. It was proposed that a coefficient of 0.90 and above be used to denote excellent ratings in situations where a large range of ability exists among the athletes. When the range of ability of the athletes is smaller, a coefficient between 0.80 and 0.89 has been suggested.

The reliability of each judge was obtained by the principal components method of factoring, Equivalent standards as above to qualify an excellent rater were suggested.

Furthermore, it was proposed that the proportion of the total variance accounted for by the largest eigenvalue be used to assess the quality of the judging of an event. It was also suggested that the mean proportion of the total variance accounted forby the largest eigenvalue for the six events be used as an overall indication of the quality of the ratings for a whole competition.

Finally, four methods of assessing the performance score were compared. However the results obtained did not suggest the superiority of one method over another.

## Conclusion

Results of this study indicate the feasibility of assessing the quality of the ratings and the raters in order to identify competence and objectivity in gymnastic judging.

From the coefficients of average reliability of the ratings (Table 1), it was observed that there was little difference between the unadjusted and the adjusted coefficients. This could be accounted for by the similar variability in the judges' scores and would also indicate as a general rule that one judge does not tend to rate the performance higher or lower than the other judges.

It is assumed from the classical test theory model, that the average of a larger number of ratings would give a better estimate of the true performance score. However, this study gave no indication that a new scoring method should be

suggested to improve on the actual F.I.G. system.

Estimate of raters' reliability could be used to establish a profile of ability for individual judges which could be then integrated with existing certification and promotion programs. Similar profiles could also be drawn from the reliability of the ratings.

After having identified the status of Canadian judges in terms of the reliability of their ratings, more research seems to be needed to study the factors which may influence the variability of judges' scores. Because the judges do not view a performance from the same angle and the same position, do they really assess the same performance? This aspect of the validity of the ratings is certainly worthy of consideration.

It was observed that lower coefficients of reliability of the ratings and the raters were obtained for the final competition at the National Meet. Since the final was held at the end of the third day of competition, it is suggested that a fatigue factor on the part of the judges might have affected the quality of the ratings. This area of investigation could be the object of further research.

Finally, since human judging is employed in other areas of athletic competition such as skiing, skating and diving, a comparison of the reliability of their different systems of rating could be valuable.

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APPENDICES

# APPENDIX A

## INTERCOLLEGIATE MEET: EDMONTON, 1971

TABLE 6

Intercollegiate Meet: Edmonton, 1971

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 4.0 | 6.7 | 4.7 | 4.8 | 4.2 | 4.75 |
| 2 | 4.5 | 4.8 | 5.4 | 5.1 | 4.8 | 4.85 |
| 3 | 4.5 | 4.6 | 5.5 | 4.3 | 4.4 | 4.50 |
| 4 | 4.7 | 4.2 | 4.2 | 4.1 | 4.6 | 4.20 |
| 5 | 4.6 | 5.4 | 5.5 | 4.7 | 4.9 | 5.15 |
| 6 | 8.0 | 7.2 | 7.6 | 6.7 | 7.5 | 7.25 |
| 7 | 4.0 | 3.6 | 4.9 | 4.8 | 4.0 | 4.40 |
| 8 | 3.8 | 4.5 | 5.2 | 2.9 | 4.3 | 4.40 |
| 9 | 6.0 | 5.2 | 5.4 | 6.1 | 6.3 | 5.75 |
| 10 | 7.6 | 7.0 | 7.2 | 6.9 | 8.1 | 7.10 |
| 11 | 8.9 | 7.4 | 8.7 | 8.8 | 9.0 | 8.75 |
| 12 | 8.4 | 8.0 | 8.3 | 8.6 | 9.0 | 8.45 |
| 13 | 8.6 | 8.2 | 7.7 | 8.0 | 8.7 | 8.10 |
| 14 | 9.0 | 8.6 | 8.4 | 8.9 | 8.9 | 8.75 |
| 15 | 9.1 | 8.6 | 8.6 | 9.0 | 9.0 | 8.80 |
| 16 | 6.2 | 7.8 | 6.4 | 5.9 | 5.6 | 6.15 |
| 17 | 5.6 | 5.8 | 5.4 | 5.8 | 5.8 | 5.80 |
| 18 | 7.0 | 7.6 | 8.0 | 6.8 | 7.2 | 7.40 |
| 19 | 6.8 | 8.2 | 6.6 | 6.7 | 6.9 | 6.80 |
| 20 | 8.2 | 8.3 | 8.1 | 8.2 | 8.1 | 8.15 |
| 21 | 8.3 | 6.0 | 8.2 | 8.0 | 8.1 | 8.05 |
| 22 | 4.3 | 4.7 | 3.4 | 3.0 | 4.3 | 3.85 |
| 23 | 4.0 | 4.3 | 5.4 | 3.0 | 5.3 | 4.70 |
| 24 | 4.0 | 4.4 | 5.0 | 3.5 | 4.0 | 4.20 |
| 25 | 4.1 | 4.3 | 5.0 | 3.9 | 5.3 | 4.65 |
| 26 | 8.7 | 8.6 | 8.8 | 9.1 | 8.7 | 8.75 |

TABLE 6 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Horizontal Bar | | | |
| 1 | 5.5 | 4.5 | 6.0 | 5.8 | 5.2 | 5.50 |
| 2 | 4.7 | 4.8 | 5.6 | 5.0 | 5.6 | 5.30 |
| 3 | 4.8 | 5.8 | 6.2 | 5.0 | 5.5 | 5.65 |
| 4 | 5.6 | 4.1 | 5.8 | 5.0 | 5.1 | 5.05 |
| 5 | 7.8 | 7.3 | 8.2 | 7.2 | 7.6 | 7.45 |
| 6 | 7.8 | 7.5 | 7.8 | 7.6 | 7.8 | 7.70 |
| 7 | 4.5 | 4.0 | 4.0 | 6.2 | 4.3 | 4.15 |
| 8 | 5.1 | 4.4 | 5.2 | 4.0 | 4.8 | 4.60 |
| 9 | 7.0 | 6.9 | 7.4 | 6.0 | 6.9 | 6.90 |
| 10 | 5.0 | 3.8 | 5.3 | 4.6 | 4.8 | 4.70 |
| 11 | 4.0 | 3.3 | 4.8 | 4.4 | 5.0 | 4.60 |
| 12 | 3.0 | 2.2 | 2.5 | 2.6 | 4.4 | 2.55 |
| 13 | 2.0 | 2.0 | 2.0 | 2.0 | 3.0 | 2.00 |
| 14 | 4.4 | 4.0 | 4.0 | 3.7 | 5.0 | 4.00 |
| 15 | 6.5 | 6.7 | 6.6 | 6.2 | 7.0 | 6.65 |
| 16 | 8.1 | 7.6 | 8.0 | 7.8 | 7.2 | 7.70 |
| 17 | 5.2 | 5.1 | 6.6 | 5.5 | 6.4 | 5.95 |
| 18 | 6.8 | 6.6 | 7.0 | 7.0 | 7.2 | 7.00 |
| 19 | 6.3 | 5.4 | 6.4 | 6.2 | 6.8 | 6.30 |
| 20 | 4.0 | 3.2 | 4.8 | 4.4 | 5.2 | 4.60 |
| 21 | 6.2 | 6.5 | 6.6 | 6.0 | 7.0 | 6.55 |
| 22 | 5.6 | 5.9 | 6.2 | 5.8 | 6.3 | 6.05 |
| 23 | 7.2 | 7.0 | 7.6 | 6.5 | 7.0 | 7.00 |
| 24 | 7.9 | 7.6 | 8.0 | 6.8 | 7.8 | 7.70 |

TABLE 6 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Parallel Bars | | | |
| 1 | 6.0 | 6.4 | 6.5 | 5.5 | | 6.20 |
| 2 | 7.0 | 6.7 | 6.8 | 6.2 | | 6.75 |
| 3 | 6.0 | 7.1 | 6.7 | 6.8 | | 6.75 |
| 4 | 7.2 | 7.2 | 6.5 | 7.6 | | 7.20 |
| 5 | 8.1 | 7.6 | 6.7 | 7.5 | | 7.55 |
| 6 | 6.8 | 7.4 | 7.0 | 6.9 | | 6.95 |
| 7 | 3.2 | 6.2 | 4.8 | 5.4 | | 5.10 |
| 8 | 4.6 | 4.0 | 4.8 | 4.4 | | 4.50 |
| 9 | 8.4 | 7.6 | 7.8 | 7.4 | | 7.70 |
| 10 | 2.8 | 2.6 | 5.5 | 3.0 | | 2.90 |
| 11 | 4.8 | 4.3 | 5.4 | 6.6 | | 5.10 |
| 12 | 3.8 | 4.3 | 5.1 | 5.6 | | 4.70 |
| 13 | 5.9 | 7.1 | 5.6 | 6.2 | | 6.05 |
| 14 | 5.0 | 3.2 | 5.3 | 4.3 | | 4.65 |
| 15 | 2.4 | 3.5 | 3.7 | 4.6 | | 3.60 |
| 16 | 4.6 | 3.8 | 3.8 | 4.8 | | 4.20 |
| 17 | 3.4 | 3.0 | 3.2 | 4.1 | | 3.30 |
| 18 | 4.2 | 3.4 | 3.5 | 3.6 | | 3.55 |
| 19 | 4.8 | 5.7 | 6.5 | 6.8 | | 6.10 |
| 20 | 7.6 | 6.5 | 7.3 | 6.8 | | 7.05 |
| 21 | 5.8 | 6.7 | 7.1 | 6.6 | | 6.65 |
| 22 | 6.1 | 7.0 | 6.5 | 7.5 | | 6.75 |
| 23 | 4.8 | 4.2 | 6.1 | 4.1 | | 4.50 |
| 24 | 7.0 | 6.3 | 7.0 | 7.7 | | 7.00 |
| 25 | 7.4 | 7.5 | 7.0 | 8.1 | | 7.45 |
| 26 | 6.5 | 7.6 | 6.5 | 6.8 | | 6.65 |
| 27 | 8.0 | 7.9 | 8.0 | 8.7 | | 8.00 |

TABLE 6 (Continued)

Pommel Horse

| | | | | | |
|---|---|---|---|---|---|
| 1 | 3.5 | 3.6 | 3.5 | 3.4 | 3.50 |
| 2 | 4.5 | 4.8 | 3.4 | 3.9 | 4.20 |
| 3 | 4.0 | 4.3 | 3.8 | 4.0 | 4.00 |
| 4 | 4.1 | 3.4 | 4.0 | 3.7 | 3.85 |
| 5 | 5.5 | 5.2 | 5.0 | 6.0 | 5.35 |
| 6 | 3.8 | 2.9 | 3.4 | 3.8 | 3.60 |
| 7 | 4.1 | 3.4 | 3.2 | 2.8 | 3.30 |
| 8 | 5.2 | 5.6 | 4.0 | 4.8 | 5.00 |
| 9 | 8.0 | 7.5 | 8.3 | 7.0 | 7.75 |
| 10 | 5.5 | 5.8 | 6.0 | 4.2 | 5.65 |
| 11 | 3.6 | 3.5 | 5.0 | 3.8 | 3.70 |
| 12 | 1.0 | 2.4 | 3.6 | 3.4 | 2.90 |
| 13 | 2.5 | 2.9 | 3.1 | 3.5 | 3.00 |
| 14 | 2.5 | 3.2 | 3.0 | 3.2 | 3.10 |
| 15 | 3.5 | 3.5 | 3.8 | 3.6 | 3.55 |
| 16 | 4.3 | 3.2 | 3.8 | 4.6 | 4.05 |
| 17 | 5.6 | 4.7 | 5.2 | 4.4 | 4.95 |
| 18 | 7.0 | 7.1 | 5.8 | 6.4 | 6.70 |
| 19 | 5.9 | 4.8 | 5.7 | 5.8 | 5.75 |
| 20 | 5.2 | 4.0 | 5.8 | 4.9 | 5.05 |
| 21 | 5.2 | 4.4 | 5.7 | 4.0 | 4.80 |
| 22 | 6.5 | 7.8 | 6.0 | 6.2 | 6.35 |
| 23 | 6.6 | 6.1 | 7.1 | 5.6 | 6.35 |
| 24 | 6.5 | 6.3 | 6.6 | 6.1 | 6.40 |
| 25 | 5.5 | 4.5 | 5.9 | 5.2 | 5.35 |
| 26 | 4.4 | 4.6 | 3.8 | 4.0 | 4.20 |
| 27 | 5.3 | 5.0 | 4.1 | 4.2 | 4.60 |
| 28 | 6.3 | 7.4 | 5.8 | 6.3 | 6.30 |

TABLE 6 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Rings | | | |
| 1 | 3.6 | 2.5 | 2.8 | 3.5 | 3.5 | 3.15 |
| 2 | 3.7 | 3.5 | 3.0 | 3.3 | 3.7 | 3.40 |
| 3 | 4.0 | 4.4 | 3.8 | 4.8 | 4.9 | 4.60 |
| 4 | 5.0 | 5.4 | 4.5 | 4.9 | 5.3 | 5.10 |
| 5 | 5.0 | 5.9 | 4.0 | 5.4 | 5.2 | 5.30 |
| 6 | 6.0 | 5.6 | 4.6 | 5.9 | 5.8 | 5.70 |
| 7 | 5.8 | 6.4 | 4.5 | 6.0 | 5.5 | 5.75 |
| 8 | 6.0 | 6.3 | 5.4 | 5.9 | 4.7 | 5.65 |
| 9 | 6.8 | 7.1 | 6.7 | 6.1 | 7.9 | 6.90 |
| 10 | 7.8 | 7.2 | 6.4 | 6.8 | 7.2 | 7.00 |
| 11 | 4.0 | 4.0 | 4.5 | 4.2 | 4.5 | 4.35 |
| 12 | 4.1 | 4.4 | 3.0 | 4.1 | 4.0 | 4.05 |
| 13 | 7.6 | 6.2 | 6.5 | 7.8 | 6.9 | 6.70 |
| 14 | 5.0 | 5.2 | 4.0 | 4.8 | 4.4 | 4.60 |
| 15 | 3.5 | 4.5 | 3.8 | 3.0 | 3.1 | 3.45 |
| 16 | 4.0 | 3.8 | 4.2 | 3.5 | 3.6 | 3.70 |
| 17 | 4.0 | 3.5 | 3.0 | 3.1 | 3.1 | 3.10 |
| 18 | 8.0 | 6.5 | 7.1 | 7.8 | 7.6 | 7.35 |
| 19 | 8.0 | 8.3 | 8.0 | 7.5 | 7.1 | 7.75 |
| 20 | 4.1 | 4.2 | 5.0 | 4.2 | 4.9 | 4.55 |
| 21 | 4.8 | 4.0 | 5.2 | 5.3 | 5.2 | 5.20 |
| 22 | 7.4 | 5.9 | 7.0 | 7.7 | 7.4 | 7.20 |
| 23 | 7.3 | 7.1 | 7.2 | 7.0 | 7.7 | 7.15 |
| 24 | 7.5 | 7.3 | 6.8 | 6.6 | 7.3 | 7.05 |
| 25 | 7.0 | 7.2 | 6.0 | 6.9 | 6.6 | 6.75 |
| 26 | 6.8 | 6.9 | 7.2 | 7.0 | 6.9 | 6.95 |
| 27 | 7.5 | 8.2 | 7.0 | 7.9 | 7.6 | 7.75 |

TABLE 6 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Vault | | | |
| 1 | 8.6 | 8.3 | 7.9 | 8.8 | 8.2 | 8.25 |
| 2 | 8.4 | 8.1 | 8.2 | 8.3 | 8.1 | 8.15 |
| 3 | 8.6 | 8.0 | 7.9 | 8.8 | 8.4 | 8.20 |
| 4 | 6.3 | 6.0 | 5.4 | 6.9 | 5.2 | 5.70 |
| 5 | 6.8 | 6.0 | 5.6 | 6.5 | 6.5 | 6.25 |
| 6 | 7.2 | 6.9 | 7.2 | 7.0 | 6.7 | 6.95 |
| 7 | 7.1 | 6.4 | 6.2 | 7.5 | 6.2 | 6.30 |
| 8 | 7.4 | 6.8 | 7.0 | 6.7 | 6.3 | 6.75 |
| 9 | 8.6 | 8.6 | 7.8 | 8.7 | 8.4 | 8.50 |
| 10 | 6.4 | 7.3 | 6.0 | 7.5 | 7.0 | 7.15 |
| 11 | 7.6 | 7.8 | 8.0 | 8.2 | 8.1 | 7.95 |
| 12 | 8.1 | 8.4 | 7.5 | 8.1 | 8.3 | 8.20 |
| 13 | 7.6 | 8.0 | 7.4 | 7.3 | 7.5 | 7.45 |
| 14 | 7.9 | 7.9 | 7.5 | 8.0 | 8.0 | 7.80 |
| 15 | 7.6 | 8.0 | 8.0 | 8.2 | 8.3 | 8.10 |
| 16 | 7.2 | 7.1 | 7.6 | 7.1 | 7.0 | 7.10 |
| 17 | 8.2 | 8.2 | 7.8 | 8.3 | 8.1 | 8.15 |
| 18 | 9.1 | 8.8 | 8.8 | 8.8 | 9.2 | 8.80 |
| 19 | 7.1 | 6.0 | 5.0 | 6.8 | 6.0 | 6.40 |
| 20 | 6.1 | 6.2 | 5.8 | 6.2 | 5.6 | 5.90 |
| 21 | 6.2 | 6.4 | 5.9 | 6.6 | 6.2 | 6.30 |
| 22 | 7.8 | 7.0 | 7.5 | 7.8 | 7.1 | 7.30 |
| 23 | 5.6 | 6.0 | 5.8 | 5.7 | 5.2 | 5.75 |
| 24 | 8.4 | 7.9 | 8.0 | 8.2 | 8.3 | 8.10 |
| 25 | 8.0 | 8.4 | 8.4 | 8.5 | 7.3 | 8.40 |
| 26 | 9.1 | 8.8 | 8.2 | 8.9 | 8.7 | 8.75 |
| 27 | 9.3 | 9.1 | 8.8 | 9.4 | 9.2 | 9.15 |

APPENDIX B

NATIONAL TRIALS: WINNIPEG, 1973

TABLE 7

National Trials: Winnipeg, 1973

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 8.1 | 7.9 | 8.0 | 8.3 | 7.4 | 7.95 |
| 2 | 6.8 | 7.2 | 6.0 | 7.1 | 7.3 | 7.15 |
| 3 | 8.7 | 8.9 | 8.6 | 8.3 | 8.3 | 8.45 |
| 4 | 8.4 | 9.2 | 8.6 | 8.3 | 7.9 | 8.45 |
| 5 | 6.8 | 6.7 | 7.3 | 6.3 | 7.0 | 6.85 |
| 6 | 8.8 | 8.6 | 8.4 | 8.5 | 8.2 | 8.45 |
| | | | Horizontal Bar | | | |
| 1 | 8.7 | 6.6 | 9.1 | 9.0 | 8.6 | 8.80 |
| 2 | 7.5 | 6.4 | 7.8 | 7.2 | 7.9 | 7.50 |
| 3 | 7.2 | 6.0 | 7.5 | 7.7 | 7.2 | 7.35 |
| 4 | 8.9 | 9.0 | 9.3 | 9.2 | 9.0 | 9.10 |
| 5 | 7.1 | 7.3 | 7.1 | 7.8 | 7.8 | 7.55 |
| 6 | 8.0 | 7.4 | 7.7 | 7.7 | 8.9 | 7.70 |
| | | | Parallel Bars | | | |
| 1 | 7.5 | 8.0 | 7.7 | 7.4 | 8.2 | 7.85 |
| 2 | 7.8 | 7.1 | 6.3 | 7.3 | 8.1 | 7.20 |
| 3 | 7.2 | 7.5 | 7.9 | 6.8 | 7.2 | 7.35 |
| 4 | 8.0 | 8.9 | 8.5 | 8.4 | 8.4 | 8.45 |
| 5 | 6.0 | 6.5 | 6.7 | 6.9 | 6.7 | 6.70 |
| 6 | 8.0 | 8.6 | 8.2 | 7.5 | 7.8 | 8.00 |

TABLE 7 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Pommel Horse | | | |
| 1 | 6.2 | 6.0 | 5.9 | 6.7 | 5.5 | 5.95 |
| 2 | 8.2 | 8.4 | 8.2 | 7.8 | 7.5 | 8.00 |
| 3 | 8.4 | 9.0 | 8.7 | 8.3 | 8.6 | 8.65 |
| 4 | 8.7 | 8.7 | 9.1 | 8.8 | 8.4 | 8.75 |
| 5 | 7.5 | 5.8 | 6.0 | 6.7 | 7.8 | 6.35 |
| 6 | 8.0 | 8.1 | 8.1 | 8.0 | 8.2 | 8.10 |
| | | | Rings | | | |
| 1 | 7.9 | 8.0 | 7.6 | 7.9 | 8.1 | 7.95 |
| 2 | 8.8 | 8.3 | 7.7 | 8.2 | 8.0 | 8.10 |
| 3 | 6.7 | 7.5 | 7.4 | 7.0 | 6.0 | 7.20 |
| 4 | 8.4 | 9.0 | 8.1 | 8.6 | 8.4 | 8.50 |
| 5 | 5.6 | 5.1 | 5.0 | 5.1 | 6.6 | 5.10 |
| 6 | 9.0 | 8.9 | 8.7 | 8.4 | 7.9 | 8.55 |
| | | | Vault | | | |
| 1 | 9.0 | 9.2 | 9.3 | 8.7 | 8.9 | 9.05 |
| 2 | 8.1 | 7.8 | 8.9 | 8.0 | 8.0 | 8.00 |
| 3 | 9.3 | 8.9 | 9.0 | 8.9 | 9.0 | 8.95 |
| 4 | 8.7 | 9.1 | 9.0 | 8.7 | 8.7 | 8.85 |
| 5 | 8.2 | 8.9 | 7.2 | 8.4 | 8.4 | 8.40 |
| 6 | 8.9 | 9.0 | 9.5 | 8.8 | 8.8 | 8.90 |

APPENDIX C

CANADA-CHINA MEET: MONTREAL, 1973

TABLE 8

Canada-China Meet: Montreal, 1973

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 9.4 | 9.4 | 9.2 | 9.3 | 9.2 | 9.25 |
| 2 | 9.2 | 9.0 | 9.2 | 9.4 | 9.3 | 9.25 |
| 3 | 8.6 | 9.0 | 8.8 | 8.6 | 9.3 | 8.90 |
| 4 | 9.3 | 9.3 | 9.1 | 9.2 | 9.4 | 9.25 |
| 5 | 8.7 | 9.2 | 9.0 | 9.2 | 9.4 | 9.20 |
| 6 | 9.2 | 9.3 | 9.1 | 9.5 | 9.4 | 9.35 |
| 7 | 8.0 | 8.4 | 8.0 | 7.6 | 8.4 | 8.20 |
| 8 | 8.5 | 9.1 | 8.7 | 8.3 | 8.5 | 8.60 |
| 9 | 9.3 | 9.0 | 9.1 | 9.0 | 9.1 | 9.05 |
| 10 | 9.0 | 9.1 | 8.7 | 9.0 | 9.0 | 9.00 |
| 11 | 8.6 | 9.0 | 8.4 | 8.8 | 8.9 | 8.85 |
| 12 | 8.9 | 8.5 | 8.6 | 8.8 | 8.6 | 8.60 |
| | | | Horizontal Bars | | | |
| 1 | 9.4 | 9.3 | 9.3 | 9.5 | 9.4 | 9.35 |
| 2 | 9.2 | 9.5 | 9.5 | 9.4 | 9.6 | 9.50 |
| 3 | 9.0 | 9.2 | 9.2 | 8.9 | 9.2 | 9.20 |
| 4 | 9.5 | 9.2 | 9.6 | 9.5 | 9.6 | 9.55 |
| 5 | 9.4 | 9.5 | 9.4 | 9.4 | 9.5 | 9.45 |
| 6 | 9.3 | 9.3 | 9.4 | 9.4 | 9.4 | 9.40 |
| 7 | 7.9 | 8.3 | 8.2 | 7.6 | 8.0 | 8.10 |
| 8 | 8.7 | 8.4 | 8.3 | 8.2 | 7.5 | 8.25 |
| 9 | 9.1 | 9.1 | 9.1 | 9.2 | 9.2 | 9.15 |
| 10 | 9.3 | 9.2 | 9.2 | 9.2 | 9.2 | 9.20 |
| 11 | 9.0 | 9.1 | 9.0 | 9.1 | 9.2 | 9.10 |
| 12 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.00 |

TABLE 8 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Parallel Bars | | | |
| 1 | 9.1 | 9.3 | 9.4 | 9.2 | 9.3 | 9.30 |
| 2 | 9.4 | 9.4 | 9.4 | 9.6 | 9.6 | 9.50 |
| 3 | 9.4 | 9.2 | 9.2 | 9.4 | 9.3 | 9.25 |
| 4 | 9.3 | 9.3 | 9.2 | 9.2 | 9.3 | 9.25 |
| 5 | 9.0 | 9.2 | 9.3 | 9.3 | 9.3 | 9.30 |
| 6 | 9.2 | 9.1 | 9.1 | 9.2 | 9.2 | 9.15 |
| 7 | 8.5 | 8.8 | 8.8 | 8.7 | 8.4 | 8.75 |
| 8 | 9.1 | 9.0 | 9.2 | 8.9 | 9.3 | 9.10 |
| 9 | 9.2 | 9.2 | 9.1 | 8.8 | 9.0 | 9.05 |
| 10 | 8.7 | 9.0 | 9.0 | 8.7 | 8.9 | 8.95 |
| 11 | 9.0 | 8.9 | 8.9 | 9.0 | 9.1 | 8.95 |
| 12 | 7.9 | 8.3 | 7.6 | 7.9 | 7.8 | 7.85 |
| | | | Pommel Horse | | | |
| 1 | 7.6 | 7.7 | 7.6 | 8.2 | 8.0 | 7.85 |
| 2 | 7.9 | 8.4 | 7.8 | 8.4 | 8.2 | 8.30 |
| 3 | 9.3 | 9.2 | 9.0 | 9.2 | 9.3 | 9.20 |
| 4 | 9.0 | 9.1 | 9.0 | 9.1 | 9.3 | 9.10 |
| 5 | 9.3 | 9.0 | 9.1 | 8.9 | 9.2 | 9.05 |
| 6 | 7.0 | 7.9 | 7.5 | 7.7 | 7.8 | 7.75 |
| 7 | 9.5 | 9.3 | 9.4 | 9.5 | 9.4 | 9.40 |
| 8 | 9.4 | 9.2 | 9.3 | 9.1 | 9.2 | 9.20 |
| 9 | 8.9 | 9.2 | 8.9 | 9.3 | 9.0 | 9.10 |
| 10 | 9.1 | 9.1 | 9.0 | 9.2 | 9.3 | 9.15 |
| 11 | 8.9 | 9.0 | 8.6 | 9.0 | 9.0 | 9.00 |
| 12 | 9.0 | 9.3 | 8.6 | 9.2 | 9.1 | 9.15 |

TABLE 8 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Rings | | | |
| 1 | 9.3 | 9.3 | 9.0 | 9.2 | 9.2 | 9.20 |
| 2 | 9.4 | 0.3 | 8.9 | 9.5 | 9.4 | 9.35 |
| 3 | 9.2 | 9.3 | 9.3 | 9.4 | 9.4 | 9.35 |
| 4 | 9.0 | 9.3 | 9.1 | 9.2 | 9.0 | 9.15 |
| 5 | 9.1 | 9.4 | 9.2 | 9.2 | 9.2 | 9.20 |
| 6 | 9.2 | 9.3 | 9.2 | 9.2 | 9.5 | 9.25 |
| 7 | 9.0 | 9.0 | 9.1 | 9.0 | 9.1 | 9.05 |
| 8 | 8.8 | 9.0 | 8.8 | 8.9 | 9.2 | 8.95 |
| 9 | 9.0 | 9.0 | 9.0 | 8.9 | 9.0 | 9.00 |
| 10 | 9.0 | 8.9 | 9.0 | 9.0 | 9.0 | 9.00 |
| 11 | 9.1 | 9.0 | 9.0 | 9.0 | 8.6 | 9.00 |
| 12 | 6.7 | 7.0 | 6.8 | 7.0 | 7.4 | 7.00 |
| | | | Vault | | | |
| 1 | 9.4 | 8.9 | 9.2 | 9.0 | 9.2 | 9.10 |
| 2 | 9.4 | 9.2 | 9.0 | 9.2 | 9.0 | 9.10 |
| 3 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.70 |
| 4 | 8.9 | 8.9 | 8.7 | 8.8 | 8.8 | 8.80 |
| 5 | 9.0 | 9.1 | 8.9 | 9.0 | 9.1 | 9.05 |
| 6 | 9.2 | 9.1 | 9.1 | 9.3 | 9.4 | 9.20 |
| 7 | 9.2 | 9.2 | 8.9 | 9.2 | 9.0 | 9.10 |
| 8 | 9.5 | 9.5 | 9.4 | 9.6 | 9.4 | 9.45 |
| 9 | 8.9 | 9.2 | 9.3 | 9.0 | 9.0 | 9.10 |
| 10 | 8.9 | 8.7 | 8.5 | 8.7 | 8.3 | 8.60 |
| 11 | 9.3 | 9.3 | 9.2 | 9.3 | 9.2 | 9.25 |
| 12 | 9.1 | 9.3 | 9.2 | 9.2 | 9.3 | 9.25 |

APPENDIX D

NATIONAL MEET: TORONTO, 1973

TABLE 9

National Meet: Senior Men's Finals, Toronto 1973

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 9.3 | 8.6 | 8.3 | 8.9 | 8.9 | 8.75 |
| 2 | 9.0 | 8.0 | 8.4 | 8.8 | 9.0 | 8.60 |
| 3 | 8.8 | 8.4 | 8.3 | 8.2 | 8.2 | 8.25 |
| 4 | 8.6 | 8.5 | 8.5 | 8.6 | 8.6 | 8.55 |
| 5 | 8.4 | 7.4 | 8.4 | 8.0 | 7.9 | 7.95 |
| 6 | 7.9 | 8.0 | 8.4 | 8.6 | 7.8 | 8.20 |
| 7 | 8.4 | 8.0 | 8.7 | 7.9 | 8.1 | 8.05 |
| | | | Horizontal Bar | | | |
| 1 | 9.4 | 9.5 | 9.3 | 9.6 | 9.5 | 9.50 |
| 2 | 7.6 | 7.6 | 8.3 | 8.0 | 8.3 | 8.15 |
| 3 | 8.5 | 8.0 | 8.1 | 8.0 | 8.4 | 8.05 |
| 4 | 8.0 | 7.7 | 8.2 | 7.7 | 8.6 | 7.95 |
| | | | Parallel Bars | | | |
| 1 | 9.4 | 9.2 | 9.4 | 9.2 | 9.0 | 9.20 |
| 2 | 8.5 | 8.1 | 8.5 | 8.2 | 8.6 | 8.35 |
| 3 | 8.6 | 8.9 | 8.8 | 8.8 | 8.9 | 8.85 |
| 4 | 8.1 | 8.3 | 8.6 | 8.9 | 8.2 | 8.40 |
| 5 | 8.0 | 8.5 | 8.8 | 8.1 | 8.5 | 8.50 |
| 6 | 8.0 | 8.0 | 7.2 | 8.4 | 7.7 | 7.85 |

TABLE 9 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Pommel Horse | | | |
| 1 | 9.5 | 9.1 | 7.7 | 9.0 | 9.0 | 9.00 |
| 2 | 8.6 | 8.3 | 8.0 | 8.7 | 8.2 | 8.25 |
| 3 | 8.7 | 8.8 | 7.5 | 8.5 | 8.5 | 8.50 |
| 4 | 7.9 | 7.9 | 7.9 | 7.4 | 7.4 | 7.65 |
| 5 | 7.1 | 7.9 | 6.8 | 7.4 | 7.5 | 7.45 |
| 6 | 6.7 | 6.9 | 6.7 | 7.2 | 7.2 | 7.05 |
| 7 | 6.3 | 6.8 | 7.0 | 5.9 | 6.7 | 6.75 |
| | | | Rings | | | |
| 1 | 8.4 | 8.5 | 8.0 | 8.2 | 8.9 | 8.35 |
| 2 | 8.8 | 8.8 | 8.8 | 9.0 | 9.3 | 8.90 |
| 3 | 9.3 | 9.0 | 8.6 | 9.0 | 9.2 | 9.00 |
| 4 | 8.3 | 7.8 | 8.2 | 8.1 | 8.4 | 8.15 |
| 5 | 7.5 | 7.9 | 8.3 | 6.2 | 8.2 | 8.05 |
| 6 | 7.5 | 7.6 | 7.8 | 7.5 | 7.6 | 7.60 |
| 7 | 8.5 | 7.3 | 8.2 | 8.1 | 8.0 | 8.05 |
| | | | Vault | | | |
| 1 | 8.8 | 8.7 | 8.3 | 8.8 | 8.6 | 8.65 |
| 2 | 8.4 | 8.3 | 8.0 | 8.2 | 8.3 | 8.25 |
| 3 | 8.9 | 8.8 | 8.8 | 8.7 | 9.0 | 8.80 |
| 4 | 9.2 | 8.9 | 9.4 | 9.3 | 9.2 | 9.25 |
| 5 | 9.3 | 8.9 | 9.0 | 9.4 | 9.3 | 9.15 |
| 6 | 7.8 | 8.3 | 7.9 | 8.0 | 8.4 | 8.15 |
| 7 | 9.0 | 8.4 | 9.1 | 9.3 | 8.9 | 9.00 |

TABLE 10

National Meet: Senior Men's Compulsories

Ratings of the Judges and the FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 6.0 | 6.5 | 6.1 | 6.1 | 7.0 | 6.30 |
| 2 | 8.6 | 8.7 | 9.0 | 8.2 | 8.8 | 8.75 |
| 3 | 6.0 | 6.8 | 6.0 | 6.0 | 6.3 | 6.15 |
| 4 | 7.6 | 7.6 | 8.0 | 8.2 | 7.4 | 7.80 |
| 5 | 7.0 | 6.7 | 6.8 | 7.1 | 7.1 | 6.95 |
| 6 | 7.5 | 6.9 | 6.1 | 7.6 | 6.0 | 6.50 |
| 7 | 8.5 | 8.8 | 9.0 | 8.9 | 8.4 | 8.85 |
| 8 | 8.6 | 7.9 | 8.5 | 8.6 | 8.1 | 8.30 |
| 9 | 8.3 | 7.8 | 8.0 | 8.2 | 8.4 | 8.10 |
| 10 | 6.8 | 6.9 | 7.0 | 6.7 | 7.6 | 6.95 |
| 11 | 8.4 | 8.0 | 8.4 | 8.8 | 8.3 | 8.35 |
| 12 | 9.3 | 9.0 | 9.2 | 9.3 | 9.0 | 9.10 |
| 13 | 6.8 | 7.1 | 6.8 | 6.7 | 6.6 | 6.75 |
| 14 | 7.2 | 7.1 | 6.7 | 7.6 | 7.8 | 7.35 |
| 15 | 8.6 | 8.1 | 8.5 | 8.8 | 8.9 | 8.65 |
| 16 | 8.2 | 7.7 | 7.8 | 8.2 | 8.2 | 8.00 |
| 17 | 9.0 | 9.2 | 9.1 | 9.2 | 9.1 | 9.15 |

TABLE 10 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Horizontal Bar | | | |
| 1 | 5.7 | 6.2 | 6.0 | 5.8 | 5.4 | 5.90 |
| 2 | 5.8 | 7.5 | 6.2 | 5.7 | 6.5 | 6.35 |
| 3 | 8.8 | 9.1 | 8.9 | 9.1 | 8.8 | 9.00 |
| 4 | 9.2 | 9.2 | 8.8 | 8.9 | 8.6 | 8.85 |
| 5 | 9.2 | 9.1 | 9.2 | 9.3 | 9.3 | 9.25 |
| 6 | 7.8 | 7.9 | 7.5 | 7.8 | 7.5 | 7.65 |
| 7 | 9.0 | 9.2 | 8.8 | 8.9 | 8.8 | 8.85 |
| 8 | 5.8 | 5.7 | 5.4 | 6.6 | 5.8 | 5.75 |
| 9 | 7.0 | 7.2 | 7.6 | 7.4 | 7.5 | 7.45 |
| 10 | 7.5 | 7.7 | 7.9 | 7.3 | 7.0 | 7.50 |
| 11 | 5.0 | 2.5 | 5.0 | 2.4 | 4.0 | 3.25 |
| 12 | 5.0 | 5.5 | 5.5 | 5.5 | 6.4 | 5.50 |
| 13 | 8.5 | 8.5 | 8.9 | 8.5 | 8.5 | 8.50 |
| 14 | 7.5 | 7.4 | 8.0 | 7.8 | 7.5 | 7.65 |
| 15 | 3.0 | 3.8 | 4.5 | 3.0 | 4.5 | 4.15 |
| 16 | 3.0 | 3.0 | 2.5 | 3.1 | 3.5 | 3.05 |
| 17 | 8.0 | 7.7 | 8.4 | 8.4 | 9.0 | 8.40 |

TABLE 10 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Parallel Bars | | | |
| 1 | 5.9 | 4.3 | 5.6 | 4.9 | 5.6 | 5.25 |
| 2 | 8.2 | 8.3 | 8.9 | 8.6 | 8.9 | 8.75 |
| 3 | 9.2 | 9.1 | 9.1 | 9.1 | 9.1 | 9.10 |
| 4 | 7.7 | 7.9 | 8.8 | 7.3 | 8.2 | 8.05 |
| 5 | 5.0 | 3.1 | 5.1 | 3.1 | 3.5 | 3.30 |
| 6 | 5.0 | 3.5 | 4.2 | 5.0 | 5.2 | 4.60 |
| 7 | 7.5 | 7.0 | 9.0 | 7.2 | 7.4 | 7.30 |
| 8 | 4.8 | 4.0 | 5.0 | 3.1 | 4.0 | 4.00 |
| 9 | 6.9 | 6.9 | 5.8 | 6.1 | 7.4 | 6.50 |
| 10 | 8.8 | 8.7 | 9.0 | 8.8 | 8.7 | 8.75 |
| 11 | 8.9 | 9.0 | 8.9 | 9.3 | 8.9 | 8.95 |
| 12 | 9.2 | 9.4 | 9.1 | 8.7 | 9.3 | 9.20 |
| 13 | 8.2 | 8.5 | 7.8 | 8.5 | 8.6 | 8.50 |
| 14 | 8.9 | 9.3 | 8.5 | 9.2 | 9.0 | 9.10 |
| 15 | 8.7 | 8.2 | 8.6 | 8.8 | 8.8 | 8.70 |
| 16 | 6.5 | 6.1 | 6.2 | 5.6 | 7.6 | 6.15 |
| 17 | 8.7 | 9.4 | 9.0 | 8.6 | 9.1 | 9.05 |

TABLE 10 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Pommel Horse | | | |
| 1 | 8.0 | 8.0 | 7.8 | 8.0 | 8.0 | 8.00 |
| 2 | 3.6 | 2.1 | 3.9 | 4.3 | 3.6 | 3.75 |
| 3 | 8.1 | 8.4 | 8.1 | 8.3 | 8.2 | 8.25 |
| 4 | 7.8 | 7.4 | 7.4 | 8.2 | 7.9 | 7.65 |
| 5 | 9.1 | 8.8 | 8.6 | 9.0 | 9.3 | 8.90 |
| 6 | 3.6 | 3.6 | 3.2 | 4.0 | 3.9 | 3.75 |
| 7 | 5.4 | 5.1 | 5.1 | 5.4 | 5.3 | 5.20 |
| 8 | 8.6 | 8.2 | 9.1 | 8.6 | 8.3 | 8.45 |
| 9 | 8.3 | 8.6 | 9.0 | 8.8 | 8.9 | 8.85 |
| 10 | 8.7 | 8.6 | 9.2 | 8.9 | 9.1 | 9.00 |
| 11 | 2.9 | 1.6 | 0.0 | 3.4 | 2.6 | 2.10 |
| 12 | 8.7 | 9.1 | 9.3 | 8.8 | 8.6 | 8.95 |
| 13 | 6.3 | 6.6 | 6.9 | 7.2 | 7.4 | 7.05 |
| 14 | 3.0 | 3.0 | 3.1 | 4.0 | 2.2 | 3.05 |
| 15 | 3.1 | 0.0 | 1.7 | 3.0 | 2.7 | 2.20 |
| 16 | 7.2 | 6.3 | 7.2 | 7.0 | 6.5 | 6.75 |
| 17 | 7.0 | 6.0 | 6.3 | 7.6 | 6.9 | 6.60 |

[illegible]

[illegible]

[illegible]

[illegible]

TABLE 10 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Rings | | | |
| 1 | 7.5 | 7.4 | 7.6 | 7.2 | | 7.45 |
| 2 | 7.5 | 6.7 | 6.8 | 7.2 | | 7.00 |
| 3 | 8.9 | 8.8 | 8.4 | 8.6 | | 8.70 |
| 4 | 6.0 | 6.4 | 5.8 | 5.9 | | 5.95 |
| 5 | 5.5 | 5.4 | 5.4 | 5.1 | | 5.40 |
| 6 | 5.2 | 6.9 | 4.9 | 6.0 | | 5.60 |
| 7 | 8.0 | 8.2 | 8.0 | 8.2 | | 8.10 |
| 8 | 5.3 | 4.5 | 5.5 | 5.2 | | 5.25 |
| 9 | 4.7 | 6.1 | 6.5 | 5.4 | | 5.75 |
| 10 | 8.4 | 8.6 | 8.3 | 7.2 | | 8.35 |
| 11 | 8.0 | 7.9 | 7.8 | 7.8 | | 7.85 |
| 12 | 8.0 | 8.3 | 8.1 | 8.4 | | 8.20 |
| 13 | 6.3 | 6.8 | 7.3 | 7.1 | | 6.95 |
| 14 | 8.0 | 8.1 | 8.4 | 8.2 | | 8.15 |
| 15 | 8.5 | 8.5 | 8.3 | 8.7 | | 8.50 |
| 16 | 6.7 | 6.5 | 5.7 | 7.2 | | 6.60 |
| 17 | 9.5 | 9.3 | 8.8 | 9.1 | | 9.20 |

TABLE 10 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Vault | | | |
| 1 | 8.4 | 8.0 | 7.9 | 7.8 | 7.9 | 7.90 |
| 2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.3 | 8.20 |
| 3 | 8.8 | 8.4 | 8.4 | 7.9 | 8.4 | 8.40 |
| 4 | 8.0 | 7.7 | 8.1 | 8.6 | 7.6 | 7.90 |
| 5 | 6.8 | 7.5 | 7.9 | 7.2 | 7.6 | 7.55 |
| 6 | 8.7 | 8.7 | 8.3 | 8.5 | 8.6 | 8.55 |
| 7 | 8.1 | 8.0 | 8.4 | 8.8 | 7.8 | 8.20 |
| 8 | 7.9 | 7.9 | 8.3 | 8.4 | 8.2 | 8.25 |
| 9 | 8.7 | 8.4 | 8.4 | 8.1 | 8.4 | 8.40 |
| 10 | 8.3 | 8.5 | 8.6 | 8.3 | 9.0 | 8.55 |
| 11 | 8.4 | 8.5 | 9.3 | 8.3 | 8.4 | 8.45 |
| 12 | 8.5 | 8.4 | 9.0 | 8.9 | 8.7 | 8.80 |
| 13 | 8.7 | 8.7 | 7.8 | 8.4 | 8.5 | 8.45 |
| 14 | 8.1 | 8.2 | 8.8 | 7.9 | 8.0 | 8.10 |
| 15 | 9.0 | 8.7 | 8.9 | 9.1 | 9.1 | 9.00 |
| 16 | 9.5 | 9.0 | 9.2 | 9.4 | 9.2 | 9.20 |

TABLE 11

National Meet: Senior Men's Optionals, Toronto, 1973

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 8.2 | 7.8 | 8.1 | 7.9 | | 7.90 |
| 2 | 8.9 | 8.8 | 8.7 | 8.8 | | 8.75 |
| 3 | 8.7 | 8.9 | 8.6 | 8.6 | | 8.60 |
| 4 | 8.7 | 8.7 | 9.1 | 9.2 | | 9.00 |
| 5 | 9.1 | 9.1 | 9.4 | 9.3 | | 9.25 |
| 6 | 6.0 | 6.1 | 6.9 | 6.7 | | 6.40 |
| 7 | 8.1 | 7.8 | 8.6 | 7.6 | | 7.95 |
| 8 | 9.0 | 8.9 | 8.6 | 8.7 | | 8.80 |
| 9 | 7.9 | 8.3 | 8.3 | 8.2 | | 8.25 |
| 10 | 7.4 | 7.3 | 7.0 | 7.6 | | 7.35 |
| 11 | 7.4 | 7.3 | 7.6 | 7.9 | | 7.50 |
| 12 | 8.7 | 9.0 | 9.1 | 9.0 | | 9.00 |
| 13 | 7.4 | 7.3 | 8.1 | 7.5 | | 7.45 |
| 14 | 8.2 | 8.4 | 7.3 | 8.2 | | 8.30 |
| 15 | 9.0 | 9.0 | 8.9 | 8.9 | | 8.90 |
| 16 | 9.0 | 8.8 | 8.9 | 8.6 | | 8.75 |
| 17 | 8.9 | 8.9 | 9.2 | 9.2 | | 9.20 |

TABLE 11 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Horizontal Bar | | | |
| 1 | 7.0 | 7.0 | 6.5 | 5.9 | 5.8 | 6.20 |
| 2 | 7.6 | 8.2 | 7.3 | 7.5 | 8.0 | 7.75 |
| 3 | 7.6 | 7.8 | 6.9 | 8.2 | 8.1 | 7.95 |
| 4 | 6.8 | 6.0 | 6.8 | 6.7 | 6.1 | 6.40 |
| 5 | 9.2 | 8.8 | 9.2 | 9.1 | 8.7 | 8.95 |
| 6 | 8.5 | 7.9 | 6.8 | 7.7 | 8.3 | 7.80 |
| 7 | 8.3 | 8.0 | 7.3 | 7.4 | 7.2 | 7.35 |
| 8 | 8.8 | 8.6 | 8.9 | 8.9 | 9.1 | 8.90 |
| 9 | 9.1 | 9.1 | 9.0 | 9.1 | 9.1 | 9.10 |
| 10 | 9.4 | 9.5 | 9.5 | 9.8 | 9.7 | 9.60 |
| 11 | 5.7 | 5.2 | 7.1 | 4.6 | 3.2 | 4.90 |
| 12 | 8.8 | 8.5 | 8.5 | 8.7 | 7.8 | 8.50 |
| 13 | 9.1 | 8.7 | 8.8 | 8.5 | 8.9 | 8.75 |
| 14 | 7.5 | 8.8 | 8.3 | 8.6 | 8.7 | 8.65 |
| 15 | 6.3 | 6.0 | 6.8 | 5.9 | 6.0 | 6.00 |
| 16 | 6.8 | 6.9 | 6.3 | 5.8 | 4.6 | 6.05 |
| 17 | 9.0 | 9.0 | 8.5 | 9.3 | 9.0 | 9.00 |

TABLE 11 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Parallel Bars | | | |
| 1 | 6.7 | 6.5 | 4.8 | 5.9 | | 6.20 |
| 2 | 8.1 | 8.0 | 7.6 | 7.8 | | 7.90 |
| 3 | 9.2 | 9.0 | 9.0 | 9.2 | | 9.10 |
| 4 | 9.1 | 9.0 | 9.0 | 8.9 | | 9.00 |
| 5 | 9.4 | 9.5 | 9.4 | 9.5 | | 9.45 |
| 6 | 6.9 | 5.5 | 7.0 | 7.9 | | 6.95 |
| 7 | 8.7 | 7.6 | 8.6 | 8.4 | | 8.50 |
| 8 | 9.0 | 8.6 | 8.8 | 8.8 | | 8.80 |
| 9 | 6.7 | 7.2 | 7.3 | 7.1 | | 7.15 |
| 10 | 5.9 | 6.0 | 6.1 | 4.8 | | 5.95 |
| 11 | 5.3 | 5.5 | 5.3 | 4.3 | | 5.30 |
| 12 | 8.5 | 8.3 | 8.4 | 8.1 | | 8.35 |
| 13 | 8.6 | 8.6 | 8.8 | 8.9 | | 9.70 |
| 14 | 8.9 | 9.0 | 9.1 | 9.0 | | 9.00 |
| 15 | 8.8 | 8.6 | 8.8 | 8.2 | | 8.70 |
| 16 | 8.3 | 7.8 | 8.9 | 8.5 | | 8.40 |
| 17 | 8.9 | 9.3 | 9.0 | 9.0 | | 9.00 |

TABLE 11 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Pommel Horse | | | |
| 1 | 5.5 | 5.3 | 5.5 | 5.0 | 6.5 | 5.40 |
| 2 | 8.0 | 7.8 | 7.3 | 8.2 | 8.4 | 8.00 |
| 3 | 8.4 | 7.9 | 8.0 | 8.0 | 8.2 | 8.00 |
| 4 | 6.5 | 6.8 | 7.0 | 7.9 | 6.9 | 6.95 |
| 5 | 4.0 | 4.9 | 5.1 | 4.8 | 4.8 | 4.85 |
| 6 | 5.5 | 5.9 | 5.6 | 5.6 | 4.9 | 5.60 |
| 7 | 8.0 | 8.6 | 8.7 | 8.3 | 8.5 | 8.55 |
| 8 | 8.5 | 8.3 | 8.5 | 8.5 | 8.9 | 8.50 |
| 9 | 8.7 | 8.2 | 8.0 | 8.6 | 8.2 | 8.20 |
| 10 | 9.0 | 8.9 | 8.9 | 8.8 | 8.9 | 8.90 |
| 11 | 8.0 | 7.9 | 7.8 | 7.9 | 8.0 | 7.90 |
| 12 | 9.0 | 9.0 | 8.8 | 8.9 | 8.8 | 8.85 |
| 13 | 7.8 | 6.5 | 6.2 | 7.5 | 7.0 | 6.75 |
| 14 | 6.3 | 5.9 | 6.0 | 5.3 | 6.8 | 5.95 |
| 15 | 8.8 | 8.8 | 8.8 | 8.8 | 9.1 | 8.80 |
| 16 | 9.0 | 8.9 | 8.6 | 9.0 | 8.8 | 8.85 |
| 17 | 8.7 | 8.6 | 8.5 | 8.6 | 8.6 | 8.60 |

TABLE 11 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Rings | | | |
| 1 | 8.1 | 7.6 | 8.0 | 8.4 | | 8.05 |
| 2 | 8.9 | 8.9 | 7.9 | 8.7 | | 8.70 |
| 3 | 8.9 | 8.9 | 9.0 | 9.1 | | 8.95 |
| 4 | 7.9 | 7.8 | 8.0 | 7.4 | | 7.85 |
| 5 | 6.5 | 6.5 | 6.7 | 6.8 | | 6.60 |
| 6 | 6.8 | 6.4 | 6.6 | 7.3 | | 6.70 |
| 7 | 8.7 | 8.9 | 8.7 | 8.7 | | 8.70 |
| 8 | 8.4 | 9.0 | 8.8 | 8.5 | | 8.65 |
| 9 | 9.0 | 9.1 | 9.1 | 9.0 | | 9.05 |
| 10 | 8.8 | 8.8 | 8.9 | 8.8 | | 8.80 |
| 11 | 8.1 | 7.8 | 8.2 | 8.3 | | 8.15 |
| 12 | 8.4 | 8.0 | 8.6 | 8.4 | | 8.40 |
| 13 | 8.2 | 7.9 | 8.1 | 8.2 | | 8.15 |
| 14 | 7.8 | 6.9 | 7.6 | 8.3 | | 7.70 |
| 15 | 8.4 | 8.7 | 8.6 | 8.4 | | 8.50 |
| 16 | 8.8 | 8.5 | 8.7 | 8.2 | | 8.60 |
| 17 | 9.5 | 9.3 | 8.9 | 9.3 | | 9.30 |

TABLE 11 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Vault | | | |
| 1 | 8.4 | 8.1 | 8.2 | 8.7 | | 8.30 |
| 2 | 8.5 | 8.4 | 8.4 | 8.3 | | 8.40 |
| 3 | 8.7 | 8.2 | 8.6 | 9.0 | | 8.65 |
| 4 | 8.9 | 8.6 | 8.8 | 8.3 | | 8.70 |
| 5 | 7.8 | 8.2 | 8.5 | 9.2 | | 8.35 |
| 6 | 6.9 | 7.2 | 7.2 | 5.7 | | 7.05 |
| 7 | 8.7 | 7.5 | 8.1 | 8.0 | | 8.05 |
| 8 | 7.9 | 7.9 | 7.9 | 7.9 | | 7.90 |
| 9 | 8.4 | 7.2 | 8.2 | 8.5 | | 8.30 |
| 10 | 8.3 | 7.8 | 8.3 | 8.1 | | 8.20 |
| 11 | 7.2 | 7.0 | 8.1 | 7.8 | | 7.50 |
| 12 | 8.8 | 8.6 | 8.0 | 8.9 | | 8.70 |
| 13 | 8.8 | 8.8 | 9.0 | 8.7 | | 8.80 |
| 14 | 8.9 | 9.2 | 9.0 | 8.6 | | 8.95 |
| 15 | 8.5 | 8.4 | 8.6 | 8.9 | | 8.55 |
| 16 | 8.6 | 8.4 | 8.5 | 8.6 | | 8.55 |
| 17 | 8.9 | 9.1 | 9.1 | 9.0 | | 9.05 |

TABLE 12

National Meet: Junior Men's Finals, Toronto, 1973

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 8.2 | 7.9 | 7.6 | 8.0 | 7.8 | 7.85 |
| 2 | 8.5 | 7.6 | 7.5 | 8.2 | 8.1 | 7.85 |
| 3 | 7.3 | 8.1 | 7.5 | 7.4 | 7.8 | 7.65 |
| 4 | 7.3 | 7.2 | 7.3 | 6.9 | 5.9 | 7.05 |
| 5 | 6.4 | 6.9 | 6.4 | 7.0 | 7.3 | 6.95 |
| 6 | 7.8 | 7.5 | 7.6 | 8.0 | 8.3 | 7.80 |
| | | | Horizontal Bar | | | |
| 1 | 8.2 | 8.4 | 8.8 | 8.7 | 8.4 | 8.55 |
| 2 | 8.2 | 8.1 | 8.7 | 8.6 | 8.9 | 8.65 |
| 3 | 7.2 | 7.5 | 8.7 | 7.2 | 7.7 | 7.60 |
| 4 | 7.5 | 7.9 | 8.0 | 6.4 | 8.3 | 7.95 |
| 5 | 7.1 | 7.2 | 8.8 | 7.5 | 7.5 | 7.50 |
| 6 | 6.3 | 6.0 | 6.1 | 6.2 | 6.5 | 6.15 |
| | | | Parallel Bars | | | |
| 1 | 7.9 | 8.2 | 8.0 | 7.7 | 7.8 | 7.90 |
| 2 | 5.5 | 5.4 | 5.5 | 6.1 | 7.2 | 5.80 |
| 3 | 6.7 | 7.4 | 7.5 | 7.8 | 6.6 | 7.45 |
| 4 | 7.1 | 7.5 | 7.9 | 7.4 | 7.6 | 7.55 |
| 5 | 5.4 | 6.4 | 5.5 | 5.4 | 5.4 | 5.45 |
| 6 | 8.7 | 8.9 | 8.8 | 8.9 | 8.2 | 8.85 |

TABLE 12 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Pommel Horse | | | |
| 1 | 8.2 | 7.9 | 7.8 | 8.3 | 8.2 | 8.05 |
| 2 | 7.0 | 6.8 | 7.0 | 6.8 | 7.2 | 6.90 |
| 3 | 7.4 | 7.5 | 8.4 | 7.5 | 7.2 | 7.50 |
| 4 | 6.8 | 6.3 | 7.0 | 6.8 | 6.2 | 6.55 |
| 5 | 7.6 | 7.5 | 6.8 | 7.0 | 7.8 | 7.25 |
| 6 | 5.2 | 6.1 | 6.4 | 5.2 | 5.8 | 5.95 |
| | | | Rings | | | |
| 1 | 8.2 | 9.0 | 8.3 | 8.4 | 7.7 | 8.35 |
| 2 | 8.3 | 8.3 | 7.7 | 8.5 | 8.3 | 8.30 |
| 3 | 8.1 | 7.0 | 7.8 | 8.3 | 7.9 | 7.85 |
| 4 | 7.4 | 7.2 | 7.5 | 6.6 | 7.7 | 7.35 |
| 5 | 7.9 | 7.5 | 8.3 | 7.8 | 7.9 | 7.85 |
| 6 | 6.8 | 6.2 | 7.7 | 6.7 | 7.2 | 6.95 |
| | | | Vault | | | |
| 1 | 8.5 | 8.9 | 8.8 | 8.8 | 8.9 | 8.85 |
| 2 | 8.0 | 7.0 | 8.1 | 7.7 | 7.8 | 7.75 |
| 3 | 8.0 | 8.0 | 8.2 | 7.8 | 7.8 | 7.90 |
| 4 | 7.9 | 8.2 | 7.8 | 7.5 | 7.5 | 7.65 |
| 5 | 7.4 | 7.9 | 7.6 | 7.0 | 7.9 | 7.75 |
| 6 | 8.5 | 8.2 | 8.4 | 8.5 | 8.9 | 8.45 |

TABLE 13

National Meet: Junior Men's Compulsories

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 6.8 | 6.5 | 6.7 | 7.5 | 7.1 | 6.90 |
| 2 | 6.8 | 5.9 | 6.0 | 7.1 | 6.1 | 6.05 |
| 3 | 6.6 | 6.5 | 7.2 | 6.3 | 7.5 | 6.85 |
| 4 | 6.5 | 6.2 | 6.3 | 7.3 | 6.6 | 6.45 |
| 5 | 6.8 | 7.0 | 6.2 | 7.0 | 7.7 | 7.00 |
| 6 | 6.8 | 5.8 | 7.3 | 6.4 | 6.8 | 6.60 |
| 7 | 7.4 | 7.6 | 7.2 | 7.9 | 8.1 | 7.75 |
| 8 | 6.8 | 6.8 | 7.3 | 7.4 | 7.8 | 7.35 |
| 9 | 5.0 | 6.0 | 5.8 | 4.7 | 6.0 | 5.90 |
| 10 | 8.5 | 7.5 | 7.9 | 7.9 | 8.4 | 7.90 |
| 11 | 5.5 | 5.8 | 5.5 | 5.8 | 4.5 | 5.65 |
| 12 | 6.4 | 6.1 | 7.0 | 7.5 | 7.1 | 7.05 |
| 13 | 7.2 | 7.0 | 7.5 | 7.6 | 8.0 | 7.55 |
| 14 | 6.0 | 5.1 | 5.6 | 6.7 | 6.0 | 5.80 |
| 15 | 5.8 | 5.8 | 6.0 | 6.3 | 6.5 | 6.15 |
| 16 | 6.4 | 5.9 | 6.2 | 6.6 | 6.8 | 6.40 |
| 17 | 4.5 | 5.3 | 5.3 | 4.7 | 5.5 | 5.30 |
| 18 | 5.5 | 5.7 | 5.3 | 5.1 | 6.4 | 5.50 |
| 19 | 5.8 | 5.9 | 5.9 | 6.5 | 6.6 | 6.20 |
| 20 | 6.0 | 5.9 | 5.8 | 6.4 | 5.9 | 5.90 |
| 21 | 7.5 | 6.6 | 7.9 | 7.5 | 8.2 | 7.70 |
| 22 | 4.5 | 5.0 | 5.0 | 5.3 | 4.5 | 5.00 |

TABLE 13 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Horizontal Bar | | | |
| 1 | 9.0 | 8.9 | 8.5 | 8.9 | 8.7 | 8.80 |
| 2 | 6.0 | 5.5 | 6.5 | 5.8 | 6.2 | 6.00 |
| 3 | 8.9 | 8.5 | 8.8 | 9.0 | 8.0 | 8.65 |
| 4 | 5.0 | 5.1 | 7.0 | 6.2 | 5.8 | 6.00 |
| 5 | 7.2 | 6.5 | 7.0 | 6.0 | 7.4 | 6.75 |
| 6 | 9.0 | 9.0 | 8.6 | 8.8 | 8.0 | 8.70 |
| 7 | 6.5 | 6.8 | 5.5 | 5.5 | 6.3 | 5.90 |
| 8 | 4.5 | 5.4 | 4.0 | 4.8 | 5.0 | 4.90 |
| 9 | 7.0 | 7.1 | 6.0 | 7.0 | 7.0 | 7.00 |
| 10 | 4.1 | 2.8 | 4.5 | 4.5 | 5.0 | 4.50 |
| 11 | 1.5 | 1.0 | 3.0 | 1.0 | 2.0 | 1.50 |
| 12 | 3.5 | 3.5 | 4.0 | 2.0 | 3.0 | 3.25 |
| 13 | 7.5 | 8.0 | 8.7 | 7.8 | 8.4 | 8.20 |
| 14 | 8.4 | 8.3 | 8.5 | 8.6 | 8.3 | 8.40 |
| 15 | 6.8 | 6.5 | 6.5 | 6.7 | 6.5 | 6.50 |
| 16 | 9.0 | 9.3 | 9.2 | 9.0 | 9.0 | 9.10 |
| 17 | 7.2 | 6.7 | 7.1 | 7.5 | 8.0 | 7.30 |
| 18 | 8.8 | 8.8 | 8.8 | 8.9 | 8.5 | 8.80 |
| 19 | 7.9 | 7.9 | 8.1 | 8.2 | 7.5 | 8.00 |
| 20 | 7.8 | 7.4 | 7.8 | 6.9 | 6.0 | 7.15 |

TABLE 13 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Parallel Bars | | | |
| 1 | 6.2 | 5.6 | 5.0 | 4.0 | 6.5 | 5.30 |
| 2 | 7.2 | 7.7 | 8.0 | 7.3 | 7.6 | 7.65 |
| 3 | 5.8 | 4.2 | 5.2 | 1.4 | 5.4 | 4.70 |
| 4 | 5.1 | 6.0 | 5.2 | 5.1 | 5.8 | 5.50 |
| 5 | 7.6 | 7.5 | 6.3 | 7.0 | 7.2 | 7.10 |
| 6 | 5.6 | 5.1 | 4.5 | 3.8 | 4.8 | 4.65 |
| 7 | 5.6 | 5.5 | 4.8 | 6.6 | 5.7 | 5.60 |
| 8 | 6.5 | 7.3 | 6.8 | 6.0 | 6.1 | 6.45 |
| 9 | 3.0 | 3.8 | 3.4 | 3.4 | 6.8 | 3.60 |
| 10 | 3.5 | 3.0 | 6.0 | 0.7 | 4.0 | 3.50 |
| 11 | 7.3 | 7.3 | 6.8 | 7.1 | 6.7 | 6.95 |
| 12 | 5.7 | 5.7 | 6.3 | 5.7 | 5.7 | 5.70 |
| 13 | 8.6 | 9.0 | 8.5 | 8.2 | 8.1 | 8.35 |
| 14 | 6.5 | 6.1 | 6.4 | 6.3 | 4.8 | 6.20 |
| 15 | 8.2 | 8.1 | 7.0 | 8.4 | 7.7 | 7.90 |
| 16 | 6.8 | 7.0 | 6.0 | 6.7 | 5.7 | 6.35 |
| 17 | 6.0 | 6.5 | 5.8 | 6.7 | 6.5 | 6.50 |
| 18 | 6.8 | 6.5 | 7.5 | 6.7 | 6.8 | 6.75 |
| 19 | 5.6 | 5.5 | 5.8 | 4.6 | 6.3 | 5.65 |
| 20 | 8.5 | 9.0 | 8.9 | 9.2 | 8.5 | 8.95 |
| 21 | 4.0 | 4.9 | 4.8 | 4.5 | 4.7 | 4.75 |
| 22 | 4.3 | 4.9 | 4.3 | 4.9 | 3.5 | 4.60 |
| 23 | 8.3 | 8.9 | 8.5 | 9.1 | 8.3 | 8.70 |

TABLE 13 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Pommel Horse | | | |
| 1 | 8.3 | 8.2 | 7.3 | 8.6 | 8.4 | 8.30 |
| 2 | 5.2 | 5.8 | 4.7 | 5.3 | 5.9 | 5.55 |
| 3 | 8.9 | 8.8 | 8.9 | 9.0 | 8.6 | 8.85 |
| 4 | 5.3 | 3.9 | 5.9 | 5.6 | 5.7 | 5.65 |
| 5 | 7.3 | 7.0 | 7.4 | 5.8 | 6.5 | 6.75 |
| 6 | 4.1 | 2.8 | 4.3 | 5.2 | 4.5 | 4.40 |
| 7 | 6.5 | 6.6 | 7.2 | 6.4 | 6.5 | 6.55 |
| 8 | 4.3 | 3.6 | 4.9 | 3.6 | 4.2 | 3.90 |
| 9 | 5.6 | 5.3 | 6.8 | 6.0 | 5.7 | 5.85 |
| 10 | 4.8 | 2.1 | 3.0 | 5.0 | 3.9 | 3.45 |
| 11 | 4.5 | 1.4 | 5.0 | 4.2 | 4.8 | 4.50 |
| 12 | 5.0 | 3.5 | 5.8 | 5.0 | 4.9 | 4.95 |
| 13 | 1.5 | 0.3 | 2.0 | 2.6 | 4.0 | 2.30 |
| 14 | 2.0 | 2.6 | 2.0 | 2.9 | 3.8 | 2.75 |
| 15 | 4.4 | 4.3 | 5.1 | 5.0 | 6.3 | 5.05 |
| 16 | 4.2 | 1.4 | 3.0 | 5.2 | 4.0 | 3.50 |
| 17 | 8.7 | 8.9 | 8.5 | 8.4 | 8.3 | 8.45 |
| 18 | 5.5 | 5.3 | 5.2 | 5.4 | 6.0 | 5.35 |
| 19 | 8.0 | 7.6 | 8.0 | 7.2 | 8.0 | 7.80 |
| 20 | 6.5 | 6.4 | 6.1 | 6.6 | 7.5 | 6.50 |
| 21 | 5.8 | 5.9 | 6.0 | 6.8 | 6.5 | 6.25 |

TABLE 13 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Rings | | | |
| 1 | 9.0 | 9.0 | 8.8 | 8.9 | | 8.95 |
| 2 | 7.2 | 7.3 | 7.4 | 7.3 | | 7.30 |
| 3 | 8.9 | 8.8 | 8.4 | 9.2 | | 8.85 |
| 4 | 6.5 | 7.9 | 7.0 | 7.0 | | 7.00 |
| 5 | 8.4 | 8.3 | 8.2 | 8.2 | | 8.25 |
| 6 | 8.8 | 8.2 | 8.4 | 8.1 | | 8.30 |
| 7 | 7.5 | 7.3 | 7.5 | 7.2 | | 7.40 |
| 8 | 4.7 | 5.1 | 5.0 | 5.5 | | 5.05 |
| 9 | 6.9 | 8.0 | 8.2 | 8.0 | | 8.00 |
| 10 | 6.2 | 6.9 | 7.0 | 6.5 | | 6.70 |
| 11 | 6.5 | 7.1 | 6.7 | 6.1 | | 6.60 |
| 12 | 6.0 | 5.8 | 6.0 | 5.9 | | 5.95 |
| 13 | 5.5 | 5.2 | 5.5 | 5.5 | | 5.50 |
| 14 | 8.6 | 8.7 | 7.7 | 8.5 | | 8.65 |
| 15 | 6.5 | 6.3 | 7.1 | 6.9 | | 6.70 |
| 16 | 7.9 | 8.0 | 8.0 | 7.8 | | 7.95 |
| 17 | 8.0 | 8.0 | 7.9 | 6.6 | | 7.95 |
| 18 | 9.0 | 8.5 | 8.8 | 8.6 | | 8.70 |
| 19 | 7.9 | 8.1 | 7.9 | 8.2 | | 8.00 |
| 20 | 7.9 | 8.7 | 9.2 | 8.5 | | 8.60 |
| 21 | 6.9 | 7.2 | 7.8 | 6.5 | | 7.05 |
| 22 | 7.9 | 7.9 | 7.9 | 8.1 | | 7.90 |

TABLE 13 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Vault | | | |
| 1 | 7.3 | 7.9 | 7.3 | 7.2 | 7.7 | 7.50 |
| 2 | 8.4 | 8.4 | 7.8 | 7.8 | 6.1 | 7.80 |
| 3 | 7.9 | 8.3 | 7.5 | 8.8 | 8.1 | 8.20 |
| 4 | 6.3 | 7.7 | 7.5 | 7.5 | 7.3 | 7.50 |
| 5 | 8.8 | 8.5 | 8.5 | 8.5 | 8.4 | 8.50 |
| 6 | 7.4 | 8.0 | 7.3 | 7.2 | 7.8 | 7.45 |
| 7 | 7.9 | 7.6 | 7.9 | 7.5 | 7.3 | 7.55 |
| 8 | 4.5 | 4.9 | 4.5 | 5.0 | 5.0 | 4.95 |
| 9 | 6.0 | 6.9 | 6.0 | 6.0 | 6.0 | 6.00 |
| 10 | 6.7 | 6.7 | 6.1 | 6.5 | 6.8 | 6.60 |
| 11 | 6.2 | 6.9 | 6.0 | 6.3 | 6.3 | 6.30 |
| 12 | 8.0 | 7.4 | 7.5 | 8.0 | 8.1 | 7.75 |
| 13 | 8.8 | 8.9 | 7.8 | 8.9 | 8.6 | 8.75 |
| 14 | 8.2 | 8.0 | 7.9 | 8.5 | 7.7 | 7.95 |
| 15 | 7.6 | 7.6 | 7.4 | 7.6 | 8.4 | 7.60 |
| 16 | 8.0 | 8.4 | 8.3 | 8.2 | 8.3 | 8.30 |
| 17 | 7.4 | 8.0 | 7.3 | 7.4 | 7.8 | 7.60 |
| 18 | 8.0 | 7.5 | 8.0 | 8.4 | 7.9 | 7.95 |
| 19 | 5.7 | 6.0 | 5.1 | 6.1 | 7.5 | 6.05 |
| 20 | 8.3 | 7.8 | 7.8 | 8.0 | 8.1 | 7.90 |
| 21 | 6.0 | 6.3 | 6.0 | 6.0 | 6.0 | 6.00 |

TABLE 14

National Meet: Junior Men's Optionals

Ratings of the Judges and FIG Mean Score

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Floor Exercises | | | |
| 1 | 7.2 | 7.1 | 6.9 | 7.5 | | 7.15 |
| 2 | 8.4 | 8.3 | 8.1 | 8.4 | | 8.35 |
| 3 | 7.9 | 7.5 | 7.1 | 8.2 | | 7.70 |
| 4 | 7.0 | 6.3 | 7.4 | 7.4 | | 7.20 |
| 5 | 6.3 | 6.1 | 5.7 | 6.5 | | 6.20 |
| 6 | 6.9 | 6.1 | 5.6 | 6.5 | | 6.30 |
| 7 | 5.0 | 5.4 | 5.9 | 4.7 | | 5.20 |
| 8 | 9.2 | 8.6 | 8.7 | 9.0 | | 8.85 |
| 9 | 5.0 | 4.3 | 4.9 | 5.0 | | 4.95 |
| 10 | 8.2 | 8.5 | 8.6 | 8.7 | | 8.55 |
| 11 | 5.5 | 5.4 | 5.8 | 5.1 | | 5.45 |
| 12 | 8.9 | 8.6 | 8.7 | 8.9 | | 8.80 |
| 13 | 5.4 | 6.1 | 6.8 | 5.7 | | 5.90 |
| 14 | 7.8 | 7.4 | 6.9 | 8.1 | | 7.60 |
| 15 | 7.9 | 7.6 | 7.6 | 8.4 | | 7.75 |
| 16 | 7.0 | 7.6 | 7.3 | 6.0 | | 7.15 |
| 17 | 6.8 | 6.7 | 6.9 | 6.2 | | 6.75 |
| 18 | 8.0 | 8.5 | 7.9 | 8.1 | | 8.05 |
| 19 | 6.8 | 7.2 | 6.2 | 6.9 | | 6.85 |
| 20 | 7.2 | 8.1 | 8.1 | 7.8 | | 7.95 |
| 21 | 6.8 | 6.4 | 5.8 | 6.9 | | 6.60 |
| 22 | 8.7 | 8.5 | 8.2 | 8.5 | | 8.50 |

TABLE 14 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Horizontal Bar | | | |
| 1 | 6.3 | 4.9 | 4.6 | 5.4 | 6.9 | 5.15 |
| 2 | 4.8 | 5.5 | 3.8 | 5.5 | 5.5 | 5.50 |
| 3 | 6.6 | 7.6 | 7.3 | 6.7 | 7.6 | 7.45 |
| 4 | 5.8 | 5.3 | 4.8 | 5.6 | 5.0 | 5.15 |
| 5 | 4.2 | 2.5 | 3.2 | 4.0 | 2.5 | 2.85 |
| 6 | 4.0 | 2.5 | 5.4 | 3.8 | 3.0 | 3.40 |
| 7 | 4.5 | 4.0 | 4.0 | 4.8 | 3.5 | 4.00 |
| 8 | 8.6 | 8.4 | 7.7 | 8.5 | 8.5 | 8.45 |
| 9 | 8.5 | 8.7 | 9.1 | 8.9 | 8.8 | 8.85 |
| 10 | 6.0 | 5.6 | 6.5 | 6.0 | 6.2 | 6.10 |
| 11 | 8.4 | 8.9 | 9.1 | 9.0 | 9.2 | 9.05 |
| 12 | 6.7 | 7.1 | 6.6 | 7.1 | 6.8 | 6.95 |
| 13 | 6.8 | 6.1 | 5.6 | 5.8 | 5.6 | 5.70 |
| 14 | 8.3 | 8.3 | 8.6 | 7.0 | 8.7 | 8.45 |
| 15 | 6.1 | 4.7 | 5.6 | 6.2 | 4.7 | 5.15 |
| 16 | 6.8 | 6.0 | 5.4 | 6.8 | 5.8 | 5.90 |
| 17 | 8.4 | 8.0 | 7.4 | 9.0 | 7.9 | 7.95 |
| 18 | 7.3 | 6.0 | 4.8 | 6.3 | 5.2 | 5.60 |
| 19 | 8.2 | 8.0 | 6.8 | 7.1 | 7.6 | 7.35 |
| 20 | 5.7 | 5.9 | 5.9 | 7.3 | 5.4 | 5.90 |
| 21 | 8.2 | 6.8 | 7.2 | 7.8 | 6.8 | 7.00 |

TABLE 14 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Parallel Bars | | | |
| 1 | 6.0 | 6.5 | 5.1 | 5.5 | | 5.75 |
| 2 | 3.4 | 4.8 | 4.5 | 5.3 | | 4.65 |
| 3 | 8.4 | 8.4 | 8.3 | 8.0 | | 8.35 |
| 4 | 5.3 | 5.0 | 5.2 | 5.8 | | 5.25 |
| 5 | 7.9 | 6.8 | 5.2 | 7.1 | | 6.95 |
| 6 | 6.1 | 6.5 | 6.4 | 7.4 | | 6.45 |
| 7 | 6.5 | 7.2 | 7.9 | 6.4 | | 6.85 |
| 8 | 7.0 | 6.5 | 5.9 | 6.7 | | 6.60 |
| 9 | 7.5 | 7.9 | 7.6 | 7.0 | | 7.55 |
| 10 | 6.7 | 6.5 | 6.5 | 6.0 | | 6.50 |
| 11 | 6.9 | 7.9 | 7.9 | 7.5 | | 7.70 |
| 12 | 4.5 | 4.2 | 4.4 | 5.0 | | 4.45 |
| 13 | 4.3 | 5.0 | 4.2 | 5.4 | | 4.65 |
| 14 | 4.5 | 4.0 | 4.3 | 5.4 | | 4.40 |
| 15 | 7.8 | 7.8 | 7.9 | 8.0 | | 7.85 |
| 16 | 4.2 | 5.0 | 4.2 | 3.5 | | 4.20 |
| 17 | 7.9 | 7.8 | 7.9 | 7.3 | | 7.85 |
| 18 | 6.5 | 6.0 | 5.8 | 5.9 | | 5.95 |
| 19 | 8.9 | 8.3 | 8.0 | 8.5 | | 8.40 |
| 20 | 4.0 | 4.5 | 4.9 | 4.5 | | 4.50 |
| 21 | 5.8 | 5.8 | 5.1 | 6.1 | | 5.80 |
| 22 | 7.9 | 7.0 | 7.2 | 6.8 | | 7.10 |
| 23 | 8.3 | 8.2 | 8.3 | 7.9 | | 8.25 |
| 24 | 8.9 | 8.3 | 8.5 | 8.5 | | 8.50 |
| 25 | 8.4 | 7.0 | 7.2 | 7.2 | | 7.20 |

TABLE 14 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Pommel Horse | | | |
| 1 | 7.9 | 7.9 | 7.6 | 7.6 | 6.9 | 7.60 |
| 2 | 5.8 | 5.8 | 6.0 | 4.8 | 5.9 | 5.85 |
| 3 | 9.0 | 8.5 | 8.2 | 8.5 | 8.8 | 8.50 |
| 4 | 4.5 | 4.3 | 5.1 | 5.1 | 4.2 | 4.70 |
| 5 | 6.0 | 6.1 | 6.7 | 5.4 | 4.9 | 5.75 |
| 6 | 4.0 | 4.4 | 5.8 | 5.3 | 6.3 | 5.55 |
| 7 | 5.5 | 4.2 | 4.6 | 4.7 | 6.0 | 4.65 |
| 8 | 3.0 | 4.3 | 4.5 | 5.5 | 3.0 | 4.40 |
| 9 | 5.5 | 5.1 | 4.6 | 5.7 | 5.2 | 5.15 |
| 10 | 5.2 | 4.5 | 4.7 | 5.2 | 5.4 | 4.95 |
| 11 | 3.0 | 4.2 | 4.1 | 4.5 | 4.2 | 4.20 |
| 12 | 4.5 | 4.0 | 4.2 | 3.2 | 4.5 | 4.10 |
| 13 | 5.5 | 4.3 | 4.8 | 4.2 | 4.4 | 4.35 |
| 14 | 7.8 | 7.4 | 7.3 | 7.0 | 7.4 | 7.35 |
| 15 | 3.5 | 4.9 | 4.3 | 5.8 | 5.0 | 4.95 |
| 16 | 5.0 | 4.8 | 4.6 | 5.1 | 6.8 | 4.95 |
| 17 | 4.5 | 4.2 | 4.3 | 4.3 | 4.2 | 4.25 |
| 18 | 8.2 | 7.4 | 7.8 | 8.5 | 8.2 | 8.00 |
| 19 | 6.5 | 7.1 | 6.2 | 6.4 | 7.6 | 6.75 |
| 20 | 7.5 | 7.2 | 7.1 | 8.2 | 7.9 | 7.55 |
| 21 | 7.0 | 7.0 | 7.2 | 7.8 | 7.3 | 7.25 |
| 22 | 7.0 | 7.3 | 7.0 | 7.4 | 6.6 | 7.15 |

TABLE 14 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Rings | | | |
| 1 | 7.0 | 7.5 | 6.6 | 6.3 | | 6.80 |
| 2 | 4.5 | 4.6 | 1.5 | 5.1 | | 4.55 |
| 3 | 6.7 | 7.5 | 5.8 | 6.7 | | 6.70 |
| 4 | 5.1 | 4.8 | 5.3 | 6.1 | | 5.20 |
| 5 | 5.5 | 6.2 | 6.3 | 6.4 | | 6.25 |
| 6 | 4.3 | 5.3 | 5.7 | 6.7 | | 5.50 |
| 7 | 4.4 | 4.2 | 4.5 | 5.8 | | 4.45 |
| 8 | 8.4 | 8.8 | 8.7 | 6.9 | | 8.55 |
| 9 | 3.5 | 4.6 | 4.0 | 4.0 | | 4.00 |
| 10 | 7.5 | 7.9 | 8.2 | 7.8 | | 7.85 |
| 11 | 4.2 | 5.1 | 5.0 | 4.9 | | 4.95 |
| 12 | 8.3 | 8.5 | 8.7 | 8.4 | | 8.45 |
| 13 | 6.0 | 5.9 | 4.9 | 6.4 | | 5.95 |
| 14 | 7.5 | 7.8 | 7.9 | 8.1 | | 7.85 |
| 15 | 8.0 | 8.6 | 8.3 | 8.0 | | 8.15 |
| 16 | 6.7 | 7.7 | 6.9 | 7.2 | | 7.05 |
| 17 | 4.0 | 4.8 | 4.9 | 6.1 | | 4.85 |
| 18 | 7.5 | 8.0 | 7.2 | 8.1 | | 7.75 |
| 19 | 6.6 | 6.8 | 5.8 | 7.0 | | 6.70 |
| 20 | 6.8 | 7.3 | 6.8 | 7.3 | | 7.05 |
| 21 | 5.6 | 5.5 | 6.3 | 6.4 | | 5.95 |
| 22 | 6.5 | 6.9 | 7.5 | 7.1 | | 7.00 |

TABLE 14 (Continued)

| Subjects | S.J. | 1 | 2 | 3 | 4 | FIG Mean Score |
|---|---|---|---|---|---|---|
| | | | Vault | | | |
| 1 | 8.6 | 8.4 | 8.2 | 8.6 | | 8.50 |
| 2 | 7.4 | 7.8 | 7.0 | 7.4 | | 7.40 |
| 3 | 8.6 | 8.8 | 8.8 | 8.9 | | 8.80 |
| 4 | 8.1 | 8.1 | 8.8 | 8.2 | | 8.15 |
| 5 | 7.7 | 7.5 | 8.1 | 7.2 | | 7.60 |
| 6 | 8.3 | 8.2 | 8.6 | 7.7 | | 8.25 |
| 7 | 8.5 | 8.6 | 8.2 | 8.4 | | 8.45 |
| 8 | 8.7 | 8.4 | 7.9 | 8.3 | | 8.35 |
| 9 | 6.8 | 6.2 | 6.8 | 7.4 | | 6.80 |
| 10 | 8.3 | 8.6 | 8.0 | 7.8 | | 8.15 |
| 11 | 7.3 | 8.0 | 7.3 | 7.2 | | 7.30 |
| 12 | 8.1 | 7.6 | 8.4 | 8.5 | | 8.25 |
| 13 | 8.6 | 8.7 | 8.5 | 8.4 | | 8.55 |
| 14 | 6.5 | 6.2 | 6.7 | 6.7 | | 6.60 |
| 15 | 8.1 | 8.2 | 8.1 | 8.6 | | 8.15 |
| 16 | 6.1 | 6.3 | 6.6 | 6.2 | | 6.25 |
| 17 | 7.7 | 7.4 | 7.7 | 8.2 | | 7.70 |
| 18 | 6.2 | 6.2 | 6.8 | 6.3 | | 6.25 |
| 19 | 6.0 | 5.4 | 6.0 | 5.8 | | 5.90 |
| 20 | 7.9 | 7.6 | 7.8 | 8.1 | | 7.85 |
| 21 | 8.6 | 8.0 | 8.1 | 8.4 | | 8.25 |
| 22 | 7.9 | 7.1 | 7.6 | 7.7 | | 7.65 |

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